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The monument of the world's postal union in Berne, where the Swiss National Exhibition is being held.

"The Village"; Swiss National Exhibition, Berne, May 15th to October 15th, 1914. "The Village" is a faithful portrayal of Swiss village life.

SWISS NATIONAL EXHIBITION AT BERNE.—[See page 72.]

The Electrical Industries in Japan*

An Instructive Review of Their Present State

By Prof. Shunkichi Kimura, Ph.D.

Consulting and Commercial Engineer for Electrical Industries and Applications, Momosono, Nakano, Tokio, Japan

THE protective policy and the encouragement of home industries now in vogue in Japan for averting the disastrous trend of financial conditions as well as for improving the national standard of wealth, have created a disturbance in the system of industrial commerce which has developed during the last thirty years. But at the same time a new and interesting field has been opened up for those who will accommodate themselves to the changed conditions or for those who keep a smart lookout for new opportunities. On our side we ought not to aim at independence from the industries of the West, which might lead to our isolation; on the contrary, the relations between the industries in this country and those in the West should be made much closer than ever. Nor should our object be the exclusion of foreign arts and inventions, which will certainly lead us to sterility; on the contrary, importation and exportation must be mutual and must be encouraged to an ever-increasing extent. Home industry in Japan is progressing, no doubt, but much more slowly than in Europe and America, and in the case of electrical industries Japan is from ten to fifteen years behind other countries in the West.

In the domain of electrical industries, water-power plants throughout the country are numerous and widely distributed; those mountain streams with shallow basins, long regarded as the cause of all kinds of troubles, are now being rapidly turned into sources of electric power. According to the most reliable report, those water-power plants alone which can be most easily and economically turned to electric power amount in the aggregate to about ten million horse-power; of this only three hundred thousand have already been utilized for the public, while one half of it is in actual operation, and that mostly for lighting and power in cities and towns. Such sources of power will mean a great deal in future when they are economically employed on the spot, not with the object of selling the electricity, but in manufacturing commercial products with the energy, which may be used as transmissible motive power or can easily be transformed into intense heat or a powerful electrolytic agent.

Changes in the order of things are perplexing, not only to the foreign merchants and native contractors, but also to home industries themselves. To return to electrical industries, ordinary types of motors, generators, and transformers are now made here of creditable quality, but iron and steel of special descriptions are imported every year to a great amount. Patent rights and manufacturing processes may be acquired from abroad, but without the help of trained foreign engineers, at least during the trial stage, it will be difficult to turn out articles of high-class quality. Investigations are being made, no doubt, to a certain extent, but the progress is slow and the results doubtful, as expenses for research work are generally too heavy to be borne; in the meantime, foreign countries will make great progress, and even when the researches lead to success the market here is very small and the means for international business extremely limited. Apparently there is a great boom in electrical industries in Japan, yet if we deduct the imported articles, only a little will remain as the genuine product of home industry. One hears from contractors that all kinds of machines, both mechanical and electrical, are still imported through their hands, without any change, for places where reliable machines are in demand. These contractors are generally large firms, having long experience and trained hands. The so-called importers, whose business is conducted by foreigners with low-grade native employees, and without respectable Japanese associates, seem to have felt the effects of the change.

The study of all systems, both those which are obsolete and those which are still flourishing, must enrich one's experience and judgment and enable one to meet the changed conditions. Joint capital, joint management, exploitation of patents, and manufacturing processes—these are, generally speaking, worthy of recommendation. Of the present system of industry, as regards either sale or management on a scale fit for cheap production and a wide market, Japanese men of business have as yet had only short experience. Those industries which are now flourishing do not belong to the class of pioneer industries, and the channels of business have been prepared by the so-called importers. It will be clear that the co-operation of foreigners, trained in international business is desirable, while for the manufacture of articles, complicated as regards process, delicate in fixing, or precise in measurement, the co-operation of trained foreign hands will be imperative. But on the side of management, dealing with customers, understanding public taste, and the proper ways of speaking and writing, or in selecting the right person to communicate with—in short, in all that cannot be reached by reasoning and calculations alone—the co-operation of Japanese managers will be desirable. Further, the protective policy of the government and its general encouragement of home industries will be met by joint capitalization. The days of monopolizing interests are now gone forever, and the day has come for mutual interests with joint responsibility, the rights of both parties being justly considered and clearly defined. There are already instances of such joint capital and joint management, some of which are apparently failing, while others are likely to succeed. If we look closely into these cases, however, it will not be difficult to find out ample reasons for these failures and successes. Both kinds are equally full of lessons for those who would avail themselves of the opportunities now offered by the changed conditions. Such a change is ever to be welcomed, and here lies a chance for new men in the field.

To me it seems that foreign firms and inventors are too neglectful of securing their patent rights in Japan. All the details of their inventions, so far as they are expounded in the technical papers in their own lands, are of course open to public scrutiny here, and the so-called inventors here may resort to these papers and utilize them for their own benefit. In granting patent rights in this country, officials do not search through foreign patent records; it is advisable, therefore, that the real inventors or the lawful possessors of patent rights should pay more attention to this matter. The best thing to be done would be to secure their patent rights here, and to look at once for their exploitation, either in the form of co-operative working, or of selling the right, or else on the basis of royalties. It is to be remarked, however, that the market here, being national and not international, is, of course, too small for large industries; and the most profitable inventions will be those dealing with the commonest kinds of articles, widely used in industry or by the public, or else such as will replace others which have already created a good market in this country.

In the exploitation of inventions and manufacturing processes there is one thing which might with benefit be resorted to. This is the publication in industrial or trade journals, in the Japanese language, of the general nature of the invention, of the manufacturing facilities, of the properties of articles made, of places in which they may be most profitably employed, and so forth, accompanied with cuts or illustrations, and, when necessary, with the result of scientific testings, and with anything which will instruct people and induce them to make further inquiry. A few lines of advertisement in daily papers offering for sale the patent rights are of course useless, since their nature can only be understood by a few specialists, but not by the men who might take real interest in the transaction.

The following brief survey of the present state of electrical industries in Japan may be of some interest. The data have been collected within the last six months in the factories throughout the country and under my own personal observation.

Motors, generators, and transformers are made here in large quantities, to meet a very great demand which increases every year. As to the size, generators have been made up to 6,000 kilowatts giving very good results under test. There are two large factories with long experience, one in some connection with the General Electric Company of the United States of America, the other as a part of a dockyard. Besides there is a large factory adjoining and in possession of a copper-mine, which promises to have a splendid future. Smaller factories which turn out smaller articles are many in number, and compete keenly with each other. All special iron and steel parts are imported, and these factories have always to keep them in stock, thereby causing unnecessary loss and inconvenience. Special types of machines, and those directly coupled with water and steam turbines, have been supplied by the importers and contractors; but even these are now being made in Japan to a small extent.

Carbon filament lamps are made here in a satisfactory way, though some difficulty is experienced in making them for 220 volts, and the filaments of superior qualities are all imported. Tungsten lamps of ordinary size are also made here in many places, both drawn and squirted wires being imported. Large factories in Kawasaki and Osaka are turning out tens of thousands of lamps every day, yet hardly enough to meet the public demand.

Porcelain insulators of good quality are made here to a large amount, leaving no room for importation, as suitable raw materials are plentiful in Kiushiu and other places, but the manufacture of straight and uniform tubes seems to be limited to the length of about thirty centimeters. Most of the large factories have reliable sets of apparatus for testing insulators, but these latter, when furnished with transmission wires, sometimes give way with the normal working voltage. Among solid insulating materials other than porcelain, ebonite is the only sort which can be made in a good quality. No substitutes for ebonite nor any insulators to meet special circumstances are yet forthcoming, although such forms as lamp-sockets or ball-insulators for trolley lines are made to a great extent. Mica is largely found in Corea and Manchu, though the quality is not high-grade. It appears exposed as rock or rather as an assemblage of small rocks, and there is a prospect of finding the mineral of good quality in deeper places in the mines. It is still good enough for making some sort of micanite; but there was no factory for it till very recently, when some attempts in this direction have been made with good prospects of success. Superior kinds of mica are imported through London firms from India, and in most of the electric workshops it is used even where smaller pieces of inferior quality are good enough for the purpose. Engineers do not seem yet fully to understand the values of the different sorts of the micanite. Indeed, it is now a general feature here, that in spite of the keen competition under which they are struggling they do not look for the new materials which they may use with much profit in place of old ones, and in order to avoid the unnecessary expense in the production of their articles. Very recently a patent right for bakerite has been acquired, and the manufacture will begin after one year. India-rubber insulating tapes are made in many places, usually on a small scale and in a very primitive way. Insulating compounds and varnishes are made only to a small extent, and none with special features are yet touched upon. Transformer oils are made at oil refineries, but it is not known whether they meet the strict requirements of electrical engineers. All other oils for making varnishes and compounds are imported, and they secure good prices.

Ammeters, voltmeters, and kilowatt-hour meters are largely imported. Ammeters and voltmeters for alternating current and direct current are also made here on a fair business scale and supplied for use with small motors, but they serve for indicating rather than for measuring, and the consumers of electric power in general are indifferent. I have seen such meters in process of calibration by an ordinary workman with no proper education for such work, who was giving an allowance of 20 per cent either way, and calibrating with the fluctuating city supply as the electric source. There are some factories, however, where they make switch-board instruments, accurate to within 3 or 4 per cent, supplied with the generators made by themselves, but these cost much more than imported ones made by well-known specialist firms in America and Europe. There is no manufacturer of instruments of precision fit for scientific use. For hot-wire instruments there is difficulty in obtaining proper wires. In some factories resistance-boxes are made, but with materials having high temperature coefficients. The employment of physicists in factories began only a few years ago, and there are still places where men with no proper education hold the place of chief engineer. There is no place such as the National Physical Laboratory, or the Bureau of Standards, with a staff of the highest scientific reputation and with adequate modern equipment for research work. The development of the potentiometer must help them a great deal, but I have not seen at any commercial industrial workshop a really good potentiometer from well-known makers, and preserved in perfect condition, nor have I seen a battery of secondary cells for the electric source in calibration or testing of direct current instruments, or in driving a motor-generator

* Reproduced from the *Journal of the Royal Society of Arts.*

for alternating current instruments. Such special instruments as the oscillograph are still considered a luxurious equipment in places where they are much needed; but ohmmeters and such like are used to a great extent. Those meters, which serve in selling and buying electricity, must now pass the examination of the Teishinsho (Department of Communication). Among these meters, tariff meters are imported to a large amount, but competition being keen, and under the public idea that electric apparatus has no fixed price, they are sold at half the catalogue price, and in addition one quarter of the selling price is paid for the fee of examination. The number of these meters examined at the Teishinsho last year reached 38,000, and the figure increases every year at a rapid rate.

Resistance Materials.—None of the alloys used as the materials for electric resistances, except a small amount of German silver, are made here, and the manufacture of such alloys is in a very primitive stage. Consequently all heating elements must be imported.

Rubber works are in a prosperous condition, but not sufficiently so to stop the importation entirely. In former times these rubber works—the manufacture of ebonite and other insulating materials—were a part of the electrical industry. But they have now found their proper sphere, making such articles as toys, boots, mats, hose, tires, and packings, and the rubber works for the purpose of insulation have now become a part of wire and cable factories. Good rubber is, of course, imported from South America through London and New York firms, inferior quality rubber comes from the Straits Settlements, while the experimental cultivation of the tree in Formosa is likely to end in disappointment.

Wires.—Copper wires of all descriptions, from power cables down to silk-covered wires and rubber cored, are made here almost to the entire exclusion of imported articles, and all these factories are apparently in a prosperous condition, though competition is very keen in this as in other industries. Enameled wires are made in some of the factories, but the demand is still small and not yet established. Owners of copper mines and refineries have begun to make wires themselves, and the factories with no mines of their own are feeling a handicap in this respect. Copper wires of small diameters are drawn up to No. 50 S.W.G.; fifteen years ago I had to wait six months to import a piece of No. 42.

Dry cells are made in many places on a small scale, but the demand is increasing every year. Most of the factories do not possess the proper apparatus for testing their products, the general public accepting them untested, while in supplying governmental customers rigorous specifications are observed. Dry cells fit for storing, made of the type in which some liquid is poured in at the time they are used, are in demand by the army, the navy, and in the telegraph and telephone departments. Secondary cells of lead type are now made in two or three places, but the greater part of the demand, which is increasing every year, is supplied by importers. Those who are going to install them naturally pay attention to the life of the cells, and therefore look for the products of well-established foreign factories, native factories being still too young to insure good records for their products. Governmental customers use the native products, because they are instructed to do so, and they have no personal interest in the question.

Electric carbons for dry cells and for arc lamps, and also those carbons which do not require special processes, are made in many places, though on a small scale. Thick carbon rods for searchlights and carbon granules for telephone work are not yet made here in proper quality; carbon brushes, though made, are much inferior to imported ones.

Telephone and Telegraph Apparatus.—Public telephones and telegraphs are government monopolies, and the apparatus, being fixed in form, are old in type, except in few instances where new inventions are employed by way of trials. Most of this public telephone and telegraph apparatus has been supplied by two firms, one purely Japanese and the other in close connection with the West, and the apparatus was subjected to severe trials according to the policy of the government. As to the telephone, any new apparatus may be used after government inspection, but the public is not very particular about it. Automatic exchanges are not yet installed for public service, but semi-automatic ones will some day take the place of hard-worked female operators.

Apparatus for Domestic Electricity.—Fittings for lighting used in Japanese houses are developing to meet the taste of the people; but those for buildings of foreign style, for offices and dwelling houses, which are increasing very rapidly, are imported articles. No electric irons are made here, nor any electric heaters or cooking utensils, while electric fans are only manufactured to a very limited extent. Suppliers of electricity are now competing fiercely with one another, but for current for lighting purposes only. When this contest comes to an end, and that will be very soon, the manufacture of all kinds of apparatus for domestic purposes will rise quickly to a state of prosperity.

Garage Hazards*

MODERN garages, both public and private, besides being used for storing and housing automobiles, are usually more or less completely equipped to make repairs, and supplies of gasoline, and lubricants of various kinds are also stored about them, sometimes in considerable quantities. Explosions and fires are likely to occur from improper handling and storage of the gasoline, and accidents of many other kinds also happen. The following suggestions are made in the hope that they may tend to minimize the dangers to which garage employees, owners of automobiles, and other persons may be exposed, and to reduce the number of accidents due to carelessness and improper methods.

Gasoline should be stored in underground tanks that are located in a safe position. Most cities and large towns have ordinances that regulate the location and nature of such tanks, and fire insurance underwriters have also given careful attention to the subject. The tanks should preferably be placed so that in case of leakage the gasoline will flow away from neighboring buildings, instead of toward them. All pipes and connections used for conveying or storing gasoline should be examined frequently to detect any leaks that may exist, and if leaks are discovered they should be repaired immediately. The connection for filling the tank should be located outside of the garage, and the ground around this connection should slope away from the building, to carry off any gasoline that might be accidentally spilled during the process of unloading.

Smoking, the lighting of matches, and the use of open-flame lamps and blow torches or braziers, should be absolutely prohibited in garages. Kerosene and acetylene lights on automobiles should be extinguished while the gasoline tanks in the cars are being filled. It is dangerous to clean automobile engines and other parts of the car by the use of gasoline delivered in the form of spray, and when this method is used special care should be taken to see that there is no open flame in the vicinity. Oily cotton-waste and rags, and other similar oily and greasy material should be placed in metal cans when they are not in immediate use, and should be covered with closely fitting covers. Serious explosions are often caused in sewers by gasoline and oil that have escaped into them through the waste pipes from washing stands in garages. In many localities laws or ordinances require the use of separators, to remove oil and gasoline from the water before it reaches the sewer, and we strongly advocate the installation of such separators, even when they are not required by law. Stoves or open fires should not be used in garages. The heating should be done by steam or hot water, piped from a heater located in a separate room or in another building. Chemical fire extinguishers, or boxes containing plentiful supplies of dry sand, earth, or sawdust, should be placed in every garage to be used in case of fire, and attendants should be warned against attempting to extinguish gasoline fires with water. Sawdust or sand is best applied by a broad, flat shovel, similar to a snow shovel.

Care should be taken to avoid collisions and other accidents when entering or leaving a public garage, particularly when there is but a single door or passageway, which is used both for entrance and for exit. If the driver cannot clearly see where he is going, he should sound his horn repeatedly, and proceed very slowly and cautiously. If a doorman is in attendance, his signals should always be faithfully heeded. The reckless or careless driving and handling of cars in public garages should be prohibited.

Great care should be taken when transporting automobiles on elevators in garages. As soon as a car has been run upon the elevator platform the brakes should be set up tightly, and it is safest to stop the engine until the level is reached at which the car is to be taken off. All parts of the elevator and its mechanism should be frequently and carefully examined, and any defects that are discovered should be remedied immediately. A gate of special construction and strength should be provided at every landing. Failure to retain control of a car and bring it to a stop before it strikes the gate has caused many a serious accident, where nothing more substantial than the ordinary elevator gate has been in use. A heavy horizontal bar, made up of two angle-irons with a core of wood between them, and placed about twenty inches above the floor level, will furnish protection in cases of this kind. The gates should be provided with locks that can be operated only by the person in charge of the elevator.

Electricity is ordinarily used in garages to furnish the motive power for the elevators and for the various machine tools that are used in the repair shop, and all possible precautions should be taken to guard against accidents that may be caused by its use. Accidents are often caused by the arcing of switches on account of defective design, or because of lack of attention in operating them. Motor-starting switches having a no-volt release may cause accidents if they are allowed to get into bad condition, so that they fail to return to the starting position properly. In such a case a flash may be produced the next time the motor switch is thrown in, and the attendant may be burned. Accidents also occur when replacing fuses, because of poorly designed fuse holders. Before renewing a fuse the switch should always be opened so that the power is cut off. It is important for plug connectors to be of an approved type and well insulated, so that it will be impossible to get a shock from them. Flexible extension cords should be thoroughly insulated and should be kept in good condition; and they should not be permitted to lie in pools of water or oil that may have collected on the floor.

Good lighting is important in all parts of the garage and repair shop, and when sufficient daylight is not available an adequate number of artificial lights should be provided. These should be of an appropriate type, and they should be properly located, and provided with suitable reflectors. Nothing should be used but incandescent electric lamps. The bulbs inside the garage should be protected by wire-mesh guards, and those that are located near the gasoline supply, or where gasoline is handled, should be inclosed in stout vapor-proof glass globes. All feed wires should be placed in conduits, or be insulated in some other equally effective way. Fuse boxes and switches should be located where gasoline vapors cannot reach them.

All belts, pulleys, gears, exposed shafting, and other dangerous elements and places should be effectively guarded, and clutches or mechanical belt shifters should be provided wherever they are needed. Tools should be kept in good condition, and any that are broken and defective should be promptly discarded.

The stock rooms should be kept in an orderly condition, and all spare parts, stock, materials, and tools should be arranged in a neat and orderly manner. Tools and materials should not be left lying about on the floors, where persons may stumble over them. Particular care should be taken to keep passageways and stairways free from obstructions. Drivers of cars, repair men, and others who may have occasion to start or run automobile engines, should carefully heed the suggestions that are given with regard to the operation of the engine.

Public garages usually provide compressed air for inflating tires and for other purposes, and thoughtless persons sometimes cause injuries to others by attempting to play practical jokes with it. This is an extremely dangerous practice, and it should never be allowed.

Many of the accidents that occur in garages are caused by thoughtlessness and carelessness, and others are due to lax methods, to the omission of thorough periodical inspections of the various parts of the building and machinery, and to other causes. Care combined with faithful attention to details of every kind, will result in a considerable reduction of these accidents, and will amply repay the owners of garages in many ways.

* Reproduced from *The Travelers Standard.*

The Cable and Telegraph System of Alaska has been built up since the year 1900, when the United States Signal Corps, as a military measure, connected the scattered posts in that territory. Later, in order to obviate the necessity of sending orders and instructions over a telegraph line through foreign territory (Canada), the Alaskan system was connected by cable with Seattle, and other cables were laid between points in Alaska. The Washington-Alaska military cable and telegraph system now includes 2,636 miles of submarine cable, 1,046 miles of land lines, and 10 radio stations; and is operated by 5 officers and 200 enlisted men of the Signal Corps, whose achievements under difficult and dangerous conditions are, in the opinion of the chief signal officer, "worthy not only of high commendation, but of a place in the annals of the country." Now, according to the same officer, the time has come when this system is of little worth for military purposes compared with its value in developing the material interests of the territory, and its transfer to the Post Office Department is being urged upon Congress. It is hoped that this transfer may be effected during the present Winter.

The Northernmost National Forest is the Chugach in Alaska; the southernmost is the Luquillo in Porto Rico.

The moon, 8½ days old, as seen through the telescope.

First quarter, as seen on the sculptured moon.

Last quarter, as seen on the sculptured model.

The moon, 20½ days old, as seen through the telescope.

How a Plastic Model of the Moon Was Made

The Hemisphere of the Moon Constructed After Telescopic Photographs

By Herbert Collier

After some years of telescopic observation with a Brashear telescope I determined to undertake the task of sculpturing the moon, mainly for the purpose of attaining greater familiarity personally with every detail of the surface.

When you consider that the artist's model was some 240,000 miles away and had gained a reputation through the ages of being "fickle," some of the difficulties become apparent. Every day the moon has a different appearance—a new dress every sitting. As the sunlight creeps over the hills and lights up the mountain peaks, the view of yesterday changes, and quite a new aspect results. New valleys, great yawning craters jump into view with their dark depths untouched by even a glimmer of twilight, forming a background of Rembrandt's choosing. Continually the terminator, the irregular dawn line dividing light and darkness, is moving forward. On the earth this travels at the rate of about 1,000 miles an hour, completing the circuit of the globe in one day. On the moon this movement is about 225 miles per day, or nearly 10 miles an hour, for the earth turns round 29½ times to one revolution of the moon.

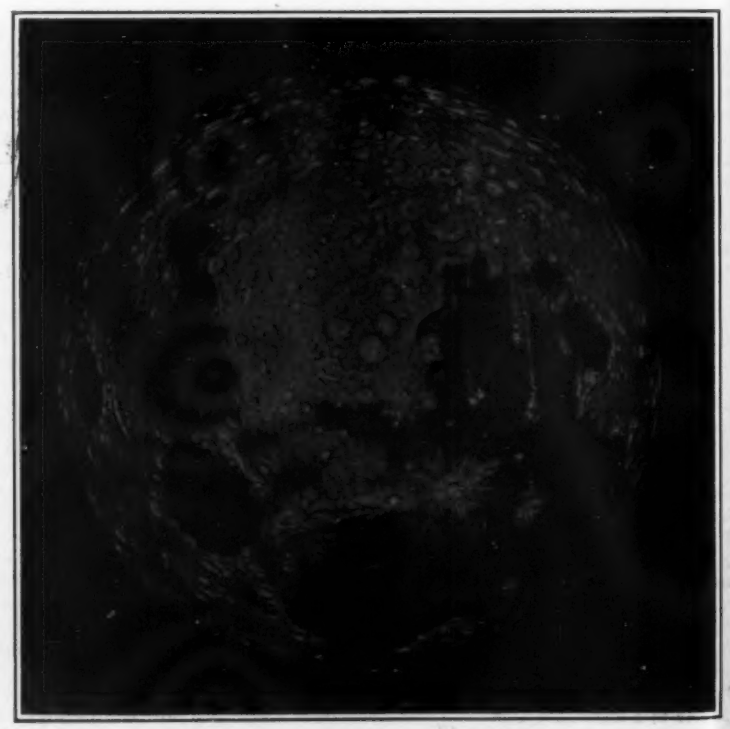
The details of craters—breadth and depth, a crag here, a precipice there—show clearly, contrasted by the shadows. But as the sun rises all this passes into blurry confusion in the fierce light of overhead rays. In such a moving picture there is a peculiar fascination. A new panorama presents itself each night to the watchful eye. To see it all is impossible, as the moon is in the visible sky for but a few hours comparatively, and nightly vigils with the telescope are sure to be interrupted frequently by cloudy weather or bad atmospheric conditions. Thus a long course of looking is obligatory before the student by personal observation knows the surface of the moon thoroughly.

Though my eye had registered through the telescope thousands of impressions of the surface markings of the moon, I dared not trust that organ solely in transferring them to sculpture. Accuracy of result demanded exact measurements. Telescopic photographs present an unchanging record. They give an indelible impression of what is revealed, and such permanent record is ready for investigation at all times. Beyond question, photography pre-eminently has enabled astronomy to merit the title given it to-day "the most exact of sciences." Therefore I made, as the foundation of my work, the best series of photographs of the moon that the world has to-day, which is known as the Paris Atlas.

Twenty years ago M. Loewy, the gifted director of the Paris Observatory, with his colleague, M. Puiseux, undertook the systematic photographing of the moon. A unique telescope was designed, and elaborate plans and specifications made for this remarkable undertaking. The instrument was an ingenious combination of a huge object-glass or light collector nearly two feet in diameter and mirrors. Equatorially mounted and driven by clockwork, the refracting lens faithfully followed the object across the sky, while the mirrors, two in number, were so arranged as to convey the image thus secured through a tube in the wall to the eye-piece situated within a comfortable room. Here the camera was attached, and the men worked free from the usual bodily discomforts associated with the ordinary telescope.

While some of the finest individual photographs of the moon have been taken by the great telescope at the Yerkes Observatory, which is the largest refracting telescope in the world, nothing can compare with the series secured by the Paris astronomers through years of devoted effort. Thousands of photographs were taken of the moon at all stages of its progress from new to full, and then on to new again. Possibly twenty would be secured one night and but one selected as good enough to enter the atlas. These pictures form a wonderful catalogue of the topography of the moon, presenting far more minute details of the surface of our own satellite

Full moon as seen in the telescopes.



Full moon as it appears on the model.

NAMES CORRESPONDING TO KEY-MAP, LOCATING ALL PROMINENT OBJECTS ON THE MOON.

1 Kästner
2 Maclaurin
3 Lapeyrouse
4 Ansger
5 Behaim
6 Hecatäus
7 Philips
8 Legendre
9 Haze
10 Furnerius
11 Marinus
12 Oken
13 Fraunhofer
14 Brisbane
15 Hannon
16 Pentecoulant
17 Biela
18 Hagecius
19 Helmholz
20 Boussingault
21 Boguslawsky
22 Manzinus
23 Mutus
24 Simpelius
25 Curtius
26 Pentland
27 Zach
28 Jacobi
29 Lilius
30 Cuvier
31 Bacon
32 Pitiscus
33 Rosenberger
34 Vlacq
35 Steinheil
36 Janssen (S)
37 Fabricius
38 Metius

78 Bianchini
79 Playfair
80 Fermat
81 Pons
82 Asophi
83 Abenezra
84 Donati
85 Faye
86 Almanon
87 Catharina
88 Cyrillus
89 Theophilus
90 Beaumont
91 Madler
92 Torricelli
93 Hypatia
94 Delambre
95 Taylor
96 Kant
97 Descartes
98 Abulfeda
99 Hipparchus
100 Albategnius

220 Wargentin
221 Weigel
222 Röst
223 Schiller
224 Bayer
225 Schickard
226 Inghirami
227 Lehmann Bouvard
228 Drebbel
229
230 Clausius
231 Lacroix
232 Piazzi
233 Lagrange

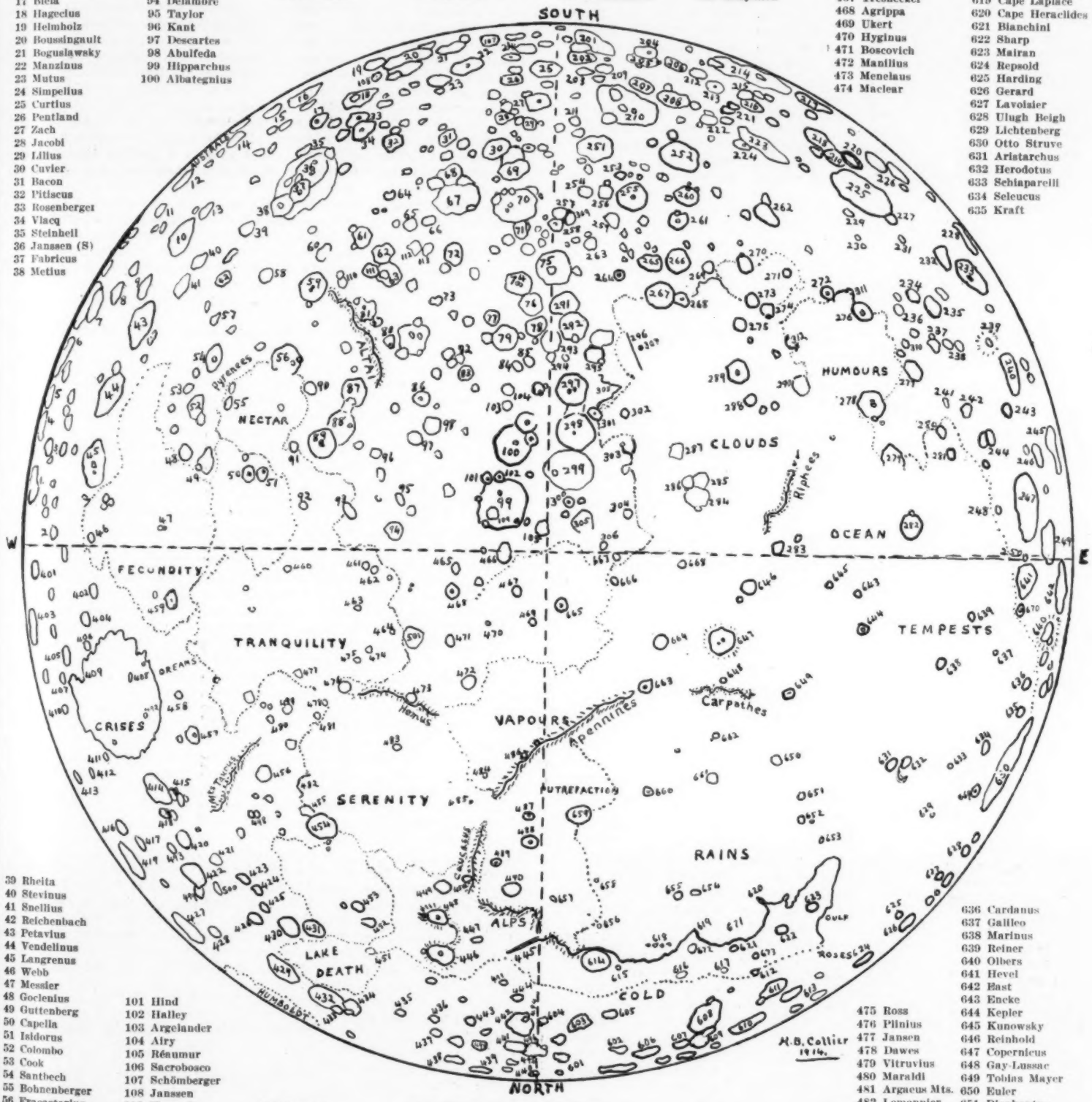
256 Pictet
257 Nasireddin
258 Miller
259 Sasserides
260 Wilhelm I.
261 Heinsius
262 Hainzel
263 Lexell
264 Heil
265 Gauricus
266 Wurzelbauer
267 Pitatus
268 Hesiodus
269 Cichus

292 Purbach
293 Lacaille
294 Delaunay
295 Thebit
296 Right Wall
297 Arzachel
298 Alphonsus
299 Ptolemäus
300 Wm. Herschel
301 Alpetragius
302 Lassell
303 Davy
304 Lalande
305 Flammarion

416 Hahn
417 Berosus
418 Burckhardt
419 Gauss
420 Geminus
421 Berzelius
422 Messala
423 Franklin
424 Cepheus
425 Oersted
426 Volta
427 Long
428 Mercurius
429 Endymion

452 Burg
453 Piana
454 Posidonius
455 Chacornac
456 Römer
457 Macrobius
458 Proclus
459 Taruntius
460 Maskelyne
461 Sabine
462 Ritter
463 Arago
464 Sosigenes
465 Godin
466 Rhaeticus
467 Tresnecker
468 Agrippa
469 Ukert
470 Hyginus
471 Boscovich
472 Manilius
473 Menelaus
474 Maclear

604 Epigenes
605 Fontenelli
606 Anaximenes
607 Carpenter
608 J. Herschel
609 Anaximander
610 Pythagoras
611 South
612 Harpalus
613 Xenophenes
614 Plato
615 Plato A.
616 Condamine
617 Bouguer
618 Straight Range
619 Cape Laplace
620 Cape Heraclides
621 Bianchini
622 Sharp
623 Mairan
624 Repsold
625 Harding
626 Gerard
627 Lavoisier
628 Ulugh Beigh
629 Lichtenberg
630 Otto Struve
631 Aristarchus
632 Herodotus
633 Schiaparelli
634 Seleucus
635 Kraft



39 Rheita
40 Stevinus
41 Snellius
42 Reichenbach
43 Petavius
44 Vendelinus
45 Langrenus
46 Webb
47 Messier
48 Goclenius
49 Guttenberg
50 Capella
51 Isidorus
52 Colombo
53 Cook
54 Santbech
55 Bohnenberger
56 Fracastorius
57 Borda
58 Neander
59 Picclomini
60 Stlborius
61 Riccius
62 Rabbi Levi
63 Zagut
64 Nicolai
65 Büshing
66 Buch
67 Maurolycus
68 Barocius
69 Licetus
70 Stöfler
71 Fernelius
72 Frisius
73 Pontanus
74 Allacensis
75 Walter
76 Werner
77 Apian

101 Hind
102 Halley
103 Argelander
104 Airy
105 Réaumur
106 Sacrobosco
107 Schömberger
108 Janssen
109 Horrocks
110 Rothmann
111 Lindenau
201 Newton
202 Moretus
203 Cysatus
204 Casalus
205 Klaproth
206 Wilson
207 Blancanus
208 Scheiner
209 Gruemberger
210 Clavius
211 Deluc
212 Kircher
213 Bettinus
214 Bailly
215 Zuchius
216 Segner
217 Mausen
218 Procylides
219 Nasmyth

234 Fourier
235 Vieta
236 Palmieri
237 Cavendish
238 Henry
239 Byrgius
240 Darwin
241 Zupus
242 Fontana
243 Crüger
244 Sirsalis
245 Trouvelot
246 Rocca
247 Grimaldi
248 Damoiseau
249 Riccioli
250 Lohrmann
251 Maginus
252 Longomontanus
253 Street
254 Saussure
255 Tycho

270 Capuanus
271 Ramsden
272 Vitello
273 Mercator
274 Campanus
275 Kies
276 Doppelmayer
277 Mersenius
278 Gassendi
279 Letronne
280 Billy
281 Hansteen
282 Flamsteed
283 Landsberg
284 Fra Mauro
285 Bonpland
286 Pamy
287 Guerike
288 Lubinieszky
289 Bullialdus
290 Agatharchides
291 Regiomontanus

306 Mösting
307 Birt
308 Prom. Aenarium
309 Huggins
310 Liebig
311 Lee
312 Hippalus
401 Schubert
402 Apollonius
403 Neper
404 Firmin
405 Condorcet
406 Ausout
407 Hansen
408 Picard
409 Cape Agarum
410 Alhazen
411 Elmmart
412 Oriani
413 Plutarch
414 Cleomedes
415 Tralles

430 Atlas
431 Hercules
432 De la Rue
433 Strabo
434 Thales
435 Democritus
436 Kant
437 Moigno
438 Euctemon
439 Challis
440 Gioja
441 Barrow
442 W. C. Bond
443 Ch. Mayer
444 Archytas
445 Alpine Valley
446 Aristoteles
447 Egede
448 Eudoxes
449 Alexander
450 Calippus
451 Baily

475 Ross
476 Plinius
477 Jansen
478 Dawes
479 Vitruvius
480 Maraldi
481 Argaeus Mts.
482 Lemonnier

483 Bessel
484 Aratus
485 Linné
486 Conon
487 Autolycus
488 Aristillus
489 Theaetetus
490 Cassini
491 Protagoras
492 Peirce
493 Bernouilli
494 Timaeus
495 Scoresby
496 Goldschmidt
497 Meton
498 Kirchhoff
499 Schumacher
500 Hooke
501 Cæsar
601 Anaxagoras
602 Philolaus
603 Birmingham

636 Cardanus
637 Galileo
638 Marinus
639 Reiner
640 Olbers
641 Hevel
642 East
643 Encke
644 Kepler
645 Kunowsky
646 Reinhold
647 Copernicus
648 Gay-Lussac
649 Tobias Mayer
650 Euler
651 Diophantus
652 Delisle
653 Gruithuisen
654 Helicon
655 Lavoisier
656 Mt. Pico
657 Mt. Piton
658 Kirch
659 Archimedes
660 Timocharis
661 Lambert
662 Pytheas
663 Eratosthenes
664 Stadius
665 Pallas
666 Schröter
667 Sömmering
668 Gambart
669 Briggs
670 Cavalerius
671 Rainbow Bay
672 Maupertius
673 Foucault

than we know of our earth in many regions. The atlas was to me a guide book superior to a personal visit.

Fearful lest through lack of knowledge of the technique of sculpture I should waste much valuable time, I devoted fully six months to the study of this special feature. Then after consultation with a number of skillful artists I commenced operations.

Plasticine appeared best suited to the conditions under which I was to labor. It is non-drying and responds quickly to manipulation with a tool. A sitting of three or four hours, then a day or two, and another sitting just as my spare time permitted, proved plasticine an excellent medium for the purpose.

"How big shall I make it?" was a troublesome question which received answer in the selection of a scale of 180 miles to the inch. The moon having a diameter of 2,160 miles, thus brought my work to a like measurement of 12 inches. This was a convenient workable basis and proved satisfactory in every respect.

Only half the moon is visible to us at any time, and, strange to say, it is always the same half. A presentation to "royalty" demands that madam turns not her back to the regal chair. The approach, the bow, and the retreat call for skillful manipulation of her troublesome train, but she must keep her face ever to the front. So the moon sedately circles about the earth, and in true subservience observes this custom with remarkable precision. Every 29½ days the moon makes the circuit of the earth. At the same time she turns completely round. Yet with provoking constancy does she keep that one side to us. A slight swaying of the ball called "libration" permits a peep at times of a little more of the "edges" than the exact half, which really makes a total of about 59 per cent of the whole surface presented at different times to the earth. Consequently, half a sphere is really all we need to represent the details of surface characteristics of the earth's satellite, which are known to mankind. Therefore, as a foundation for my model I constructed a hemisphere of selected well-dried wood, laminated to prevent warping. The entire surface was then liberally treated with shellac. With a diameter of 11 inches this wood core allowed a blanket covering of plasticine ½ inch in thickness, thus giving a total diameter of 12 inches. A board 16 by 24 inches served as the base, and to this was fastened the hemisphere of wood and plasticine. The preparations were complete. Noting the date, May 1st, 1913, actual operations commenced. It was eight months later when the finishing touches were applied.

The photograph of a ball such as the moon presents some peculiarities. Take a 12-inch photo of a 12-inch ball. Superimpose the apparent centers, at the same time wrapping the photo paper around the face of the hemisphere. It is immediately apparent that they do not correspond and will not fit. The photo paper lacks practically seven inches of covering its prototype. The reason for this is quite evident. If the photo is kept flat and vertical lines projected to the surface of the ball, they coincide perfectly. This tersely explains the method I adopted on account of its simplicity in transposing scale calculations.

A photo of the full moon is very much like the preliminary sketch of the landscape painter. The seas, those great dark regions which even the naked eye discerns plainly, are nicely outlined. Some of the more prominent craters are noted. The more important mountain ranges are roughly indicated. But the details of all these are to be shown later. I first selected such a picture, an excellent one from the 5-inch Brashear telescope of D. B. Marsh, Sc.D., F.R.A.S. Being just 12 inches in diameter, it served the purpose admirably of an outline sketch or key. Various points on this were chosen and soon projected onto the model. As the work progressed craters and prominent physical features, visible only in other photos, were first given their proper locations on this key, that they might thereby be accurately placed on the model.

Each Paris photo gave in great detail one small region. Possibly but one or two craters of importance would be shown. Another picture of the same region, but under different lighting conditions, would change the apparent physical features to a remarkable degree. Thus a number of pictures of every district, showing the changes produced by sunlight coming from the east or from the west, must be carefully compared in order to arrive at a full understanding of the real topography. With a hundred such photos before me constantly, this task was by far the greatest and of prime importance. There are no twilight shadows on the moon. A glance at a dark spot may lead to the conclusion that a great hole is there, to which the sunlight has not as yet been admitted. Further investigation of it in other pictures reveals the fact that there is no such cavity, and that the shadow is due to the peculiar conformation of an intervening hill. Though the shadows thus appear puzzling and are sometimes very misleading, they are quite necessary for an understanding of the height of a crater wall, and a hundred other measurements of the various conformations of the surface. They simply require due consideration.

The moon is a dead world. The most minute investigation indicates that nothing could be more so. A dried up, wrinkled, wizened, scarred veteran, it bears the marks of terrible conflicts, of gigantic struggles. We know not its age. Did water once rush down those wondrous mountain gorges? Did the sea ripple and play about those towering capes Laplace and Heraclides and at times dash madly against those great precipices? We can only guess. Our fancy pictures, in the distant past, smiling vegetation, life, joy, and happiness in a world of glory. It is true there are some indications of this. But death came. Like a mummy it is to-day. Life departed, embalmed, naught remains but the shrunken, desiccated, cracked carcass. The beauty of life is gone. Its history, its experiences written in the shroud, are in mysterious hieroglyphics, of which man has been able to decipher but little. To-day no grass waves on the hillside. Not a single blade would give the weary traveler a welcome. No bird warbles his cheery song there. Not even the hated snake suns himself upon the many rocks. Not an insect flits about in quest of prey. Not a breath of air stirs. Not a sign of life appears anywhere. Inconceivable desolation!

Night comes. The sun sinks behind the lofty hills, and suddenly all is dark. No twilight softly intervenes. Cloudless the sky, devoid of air and moisture, no light is reflected or refracted. There can be no diffusion of sunlight under such conditions. Black night sits side by side with brilliant day wherever the rays of the sun are intercepted. Behind the jutting rock, beneath the ledge, within the cavern of broad entrance, it is night, though day reigns supreme with intense brightness all about.

It is quite a surprise to many to learn that the earth presents more light to the moon than it receives in return. Assuming that they possess the same reflective power, the surfaces compare as 27 to 2. Thus the earth should be credited with reflecting more than thirteen times as much light as its satellite. This light thrown upon the moon is known as "earthlight," and is in all respects similar to our moonlight. When the moon begins its monthly journey around the earth by passing between the sun and us, the earth is "full moon" to it, while that body presents the phase of "new moon" to us. Thus the greatest amount of "earthlight" reaches the dark portions of the moon at this time. It is this phenomenon which gives rise to that beautiful sight, "the old moon in the young moon's arms." As the age of the moon increases, this reflected light from the earth gradually lessens until there is none at full moon. Then as the moon nears the completion of its circuit the "earthlight" continues to increase in proportion.

While the moon is making this circuit of the earth 29½ of our days pass by. Yet she takes all this time to have but one day and one night. Day brings heat unbearable in its intensity. Scorching as the flames from the inferno, the sun pours his streams of fire hour after hour until the rocks fairly dance with molecular agitation. For fourteen days without a moment's relief this continues. Then with startling suddenness night appears. A temperature more than 200 degrees below zero assails all. Without the kindly protection of a cloud, stark naked as it were, and thrust into a temperature of glacial cold from such a bed of warmth, the results must be disastrous. Such extremes of heat and cold as these cannot but result in anything less than gigantic destruction. Great yawning chasms appear everywhere on the moon, some of which extend for hundreds of miles. Close scrutiny of these numerous cracks, a thousand of which have been charted, suggests to the observer the possibility of some slight extra disturbance resulting in a general disintegration of the whole satellite.

Seismic convulsions appear to have taken place at certain centers in the early history of the moon, producing remarkable results. The exterior of the molten mass had cooled sufficiently to form a crust, a brittle glass-like covering. A large number of the so-called craters had formed. Then with further cooling of the molten interior tremendous expulsive force was exerted, bursting the outer shell and throwing out great radiating cracks in all directions, like spokes in a wheel. Lava then oozed up through these openings, in some cases but partly filling them, in others overflowing. Congealing and solidifying under different conditions from the remaining crust, this formation is quite distinctive in appearance, showing as bright streaks. The crater Tycho at the south pole is the center of the greatest system of these light streaks, and thus was at one time in the throes of a seismic disturbance of unparalleled magnitude. Some of the streaks from this center appear to encircle almost half the moon, thereby indicating the violence attendant upon this great shock.

In order to give to the eye the effect attained by telescopic observation, I took the liberties of the artist and departed from scale measurements in one respect. With 180 miles to the inch, a distance of 2 miles on the moon would be 1/90th of an inch on the model. This is less than the thickness of your business card. A lunar precipice of two miles height would be a very prominent object under proper lighting conditions, and be worthy of special attention. Yet an elevation of but 1/90th of an inch on the model would be merely the thickness of a coat of paint! Therefore the elevations were accentuated in order to produce to the eye a natural appearance, for the strict adherence to scale in this respect would create misconceptions. Careful comparison of photos of the real moon and the sculptured one, under approximately similar lighting, shows marked contrast. But this was a feature that was not in the least considered important. My aim was not to attain photographic similarity, but to convey to the eye under daylight conditions details apparent only on rare occasions with the telescope. The scientific gave place to the artistic. For such departure I plead merciful consideration from my scientific friends.

In the plaster casts made from the original, many of the finer details have been lost. As a light fall of snow on rough ground spreads a brilliant blanket, while leaving still the form of every stone and every hummock, so in the casting, the plaster obliterated the harshness of the model, softening all to a pleasing degree. A realistic telescopic appearance resulted, which in some respects compensated for the loss of details obtained only after much labor. By a careful application of a coat of paint of a bluish gray tint the maria, or seas, were given a sufficient contrast from the snow-white plaster mountains to form in all an ideal full moon.

A very interesting question appeared while calculating measurements, "What is the smallest possible discernible object on the moon? Could you see a man there? Would a big tree show?" The average human eye is credited with a power of appreciating an angle of about half a minute of arc. This, however, is quite unintelligible to most people. Let us simplify it. It means that you should see an object one inch in diameter at a distance of about five hundred and fifty-five feet. This would indicate that a "beauty plaster" of one-eighth-inch diameter upon the fair cheek of the *débutante* should be visible at some sixty-nine feet. Applied to the moon, which averages in size thirty minutes of arc, the unaided eye is capable of discerning a spot measuring one sixtieth of her diameter, or 30 seconds. Now a linear mile on the moon corresponds to 0.87 of a second. Therefore a region one mile square must be magnified by artificial means to equal 30 seconds, that the eye may even perceive it as a point. The power required is evidently about thirty-four. Measurements show that a second of arc represents about two thousand yards on the moon. Thus we would have to magnify an object of that size thirty times to bring it to discernible proportions. Two hundred yards would require ten times this power, or 300. Consequently 20 yards would demand a magnifying power of 3,000! There must be a very fine atmosphere to admit of the use of a power of 500. One thousand power is quite the limit. Even this latter magnification would bring the moon to a distance of 240 miles, and no object under sixty yards could possibly be detected, if our theory is sound. It is quite evident that a man could not be seen. A big tree would not show. Aided by the most powerful telescope, and under conditions of magnification verging upon impracticability, it would be doubtful if an object less than one hundred yards in diameter would be discernible to the human eye as anything but a mere speck. With but one hundred miles separating you from a mountain and with ideal atmospheric conditions, judge what little your naked eye could determine of the details.

Melting Points in Commercial Brasses and Bronzes

As the result of tests made under the direction of the United States Bureau of Mines, the following table of the melting-points of commercial brasses and bronzes has been summarized:

Alloy.	Approximate Composition. Copper.	Zinc.	Tin.	Lead.	Melting-point C. deg.	F. deg.
Gun-metal	88	2	10	..	995	182
Leaded gun-metal....	85½	2	9½	3	980	179
Red brass.....	85	5	5	5	970	178
Low-grade red brass	82	10	3	5	980	179
Leaded bronze.....	80	..	10	10	945	173
Bronze with zinc...	85	5	10	..	980	179
Half-yellow, half-red	75	20	2	3	920	169
Cast yellow brass...	67	31	..	2	895	164
Naval brass.....	61½	37	1½	..	855	157
Manganese bronze..	..	..	..	..	870	160

The melting-point given is the "liquidus," or point where the alloy is completely molten. The tests are described in detail in Technical Paper No. 60.—*American Machinist.*

The Aeroplane in War*

Its Possibilities and Its Limitations

By Major W. S. Brancker, R.A.

THE aeroplane is, as yet, untried in war; as although it has seen active service in Tripoli and in the Balkans, in neither of these countries were the conditions such as to afford much information concerning its possibilities. Hence their value in war and the methods of employment are only matters for conjecture. At the present time, however, armed airships and aeroplanes and weapons of offense and defense against aircraft are in existence, and therefore peace training will lack only the reality of war.

Of the many possible duties which can be performed by aeroplanes in war, the following are the most important: 1, Reconnaissance; 2, the destruction of hostile aircraft, both airships and aeroplanes; 3, the attack of troops on the ground and of material, such as airship sheds, oil tanks, magazines, etc.

1. *Reconnaissance.*—Reconnaissance is the principal duty of the aeroplane in war; it has been possible for the last two years, and will be the most important factor if war breaks out to-morrow. In this sphere, the aeroplane has come as an antidote to the growing difficulty of reconnaissance in modern warfare. Sound war plans are easily made if the enemy's forces and probable intentions are known, but the greater accuracy of long range rifle and gun-fire, increased numbers and more extended formation of troops, and the use of smokeless powder, have thickened the fog of war and made it most difficult and dangerous for cavalry to reconnoiter an enemy's position. But, given good conditions, a great deal of information can be gleaned of the enemy's dispositions, particularly during the earlier phases of a campaign, when the troops are in close formations; and an aeroplane flying at 4,000 feet should be able to bring in information ten times faster and more definite than that which a division of cavalry might normally obtain after a day's fighting.

There are, however, various adverse factors with which aerial services have to compete, and that tend to prevent any approach to infallibility in the results obtained. Among these are:

(*a*) Imperfect observation and hostile subterfuges; (*b*) climatic conditions; (*c*) difficulties of maintenance; (*d*) anti-aircraft weapons on the ground; and (*e*) fighting in the air.

(*a*) *Imperfect Observations.*—The art of accurate observation from an aeroplane is much more difficult, and requires far more training than does the art of flying. Both pilot and observer must be able to read and understand a map just as quickly and as easily as they can a book, and at any instant during a cross-country flight they should know exactly where they were. Beyond this, the observer (or in a single-seater, the pilot) must be able to pick up troops on the ground, estimate what they are, their numbers, and mark their precise position on the map. He may have to do this in a rough wind and in the midst of fleeting clouds; and on landing, write a clear and intelligible report of what he has seen. It is not therefore surprising that the results of aerial reconnaissance are sometimes inaccurate and misleading, and this weakness will be intensified by subterfuges undertaken by the enemy for the express purpose of deceiving the observer, such as by stringing out small columns along roads to represent large ones while the mass of the troops are kept hidden in woods and villages; dummy trenches may be constructed while the real trenches are hidden; guns may be made to look like bivouac shelters, bushes, or country carts, etc.

The best guarantee that aerial reconnaissance will overcome these difficulties lies in the careful training and wide experience of the observers, and in the possession of sufficient numbers of aeroplanes to enable doubtful information to be checked and corrected without delay. Assistance to full and accurate observation may be obtained by the use of aeroplanes which can fly slowly and have a good field of view, although these are somewhat handicapped in strong winds.

(*b*) *Climatic Conditions.*—Nature is the greatest enemy against reconnaissance at the moment; her weapons are wind, rain, cloud, and darkness. Wind is gradually being conquered, as aeroplanes, traveling at from 60 to 70 miles per hour, have actually been blown backward by winds they have encountered. But the great drawback to the wind is the reduced radius of action of the aeroplane. As regards the progress made against the effects of rain, the impact of the drops of rain on the eyes of the pilot blind him; but in the latest types of machine the seats were screened, so that this difficulty in flying had been largely overcome, and observation is practicable at low altitudes.

High clouds (that is, those from 3,000 feet high and upward) do not hinder observation, but rather assist it, by affording a sheltering screen to the aeroplane, if necessary, and at this altitude a pilot is comparatively safe from infantry fire; but clouds at lower elevations force the observer to come within the effective range of rifle fire from the ground. This can be remedied by the development of the armored aeroplane. Fog, however, will always presumably defeat aerial reconnaissance, just as it defeats reconnaissance on the ground. Flying in darkness is not much indulged in at present, because engines are not sufficiently reliable to eliminate the possibility of a forced landing, and a forced landing on an unknown ground usually means a bad smash, but with the really reliable engine, night flying will become universally practised.

Hence, to compete with climatic conditions there are two important requirements: (I) Reliable engines and (II) high speed. As regards speed, a machine that is fast in the air is always difficult to land, even though it can land slowly in the hands of a good pilot where the country is open. The antidote for this lies in the use of air brakes for coming down steeply, and of land brakes for pulling up quickly after touching the ground. Experiments in both are proceeding, and successful land brakes actually exist in some machines. High speed has, however, another disadvantage, namely, in still air it is much more difficult to observe accurately than from a comparatively slow aeroplane, and though it may be perfectly easy to see every detail of the country and the troops moving in it, the eye, the brain, and the hand are not quick enough to gage accurately where those troops are on the map, and to record the fact in a note-book before the aeroplane is miles farther on, and some, perhaps important, detail has been completely missed. Variable speed will get over this difficulty.

(*c*) *Difficulties of maintenance* are sometimes lost sight of. The aeroplane and its engine are both fragile and delicate. A good average pilot may fly, day after day, round an aerodrome and make many landings without even straining his machine; but in war the pilot must fly in any weather to obtain information, and land on almost any ground to deliver it. The result will be numerous breakages and strains, all of which take time and skill to repair, and which demand the provision of large quantities of spare parts wherever required on the theater of war. The difficulty of supply of spare parts will be increased in proportion to the number of different types of aeroplanes employed. Similar remarks apply to the engines, which, in addition, require thorough overhaul after a comparatively short period at work. Portable tents will also have to be carried for housing machines upon the ground to prevent serious deterioration in the flying qualities of the machines. All this points to the fact that only a small proportion of the aeroplanes in the field will be fit to take the air at any given moment.

The cures for this weakness are various, and can all be applied simultaneously. 1, Increased durability in construction; 2, reduction in the number of types of aeroplanes and engines employed; 3, the introduction of folding aeroplanes which can be more readily housed than the prevailing type; 4, a really experienced personnel.

(*d*) *Anti-aircraft Weapons on the Ground.*—All nations are endeavoring to evolve anti-aircraft guns, both fixed and mobile; but at the moment they do not exist for employment with a mobile army in the field, and for reconnaissance purposes an aeroplane is safe at 3,000 feet from rifle fire, and at 4,000 feet from gun fire. There are great inherent difficulties in firing at aeroplanes, principally in regard to range, speed, and direction of the machine; while it is almost impossible to recognize whether it is friendly or hostile, although attempts were being made to help to differentiate between them.

(*e*) *Fighting in the Air.*—It is obvious that if hostile aeroplanes are armed with a weapon which can be used against the purely reconnaissance machine, the information brought in by the latter will, very likely, be greatly depreciated in value and in volume, and may not come in at all, and that to combat the armed aeroplane it is necessary to pit other armed aircraft against it.

Aeroplanes will not entirely relieve the cavalry of reconnaissance work, for cavalry reconnaissance succeeds where aeroplane reconnaissance fails, as cavalry can distinguish between friends and hostile troops, can discern the *morale* and physical condition of the enemy; it can keep in touch with any particular body of the enemy, and can offer opposition to its advance. The leader of the future will employ his aeroplanes and his cavalry so that one supplements the other, and the employment of the aeroplane in the initial stages of a campaign will enable a commander-in-chief to hold his cavalry back and save them much long and fruitless work, thus keeping them fresh for fighting when the main armies begin to close. The aeroplane will also enable the effect of artillery fire to be observed, thereby solving a difficulty which has been growing more and more acute during recent times; while intercommunication between widely separated forces will also be readily possible with any aeroplane suitable for reconnaissance.

All that has been claimed so far has been actually accomplished in peace and could be accomplished in war, while the suggested improvements and developments are practical possibilities, and are actually under experiment at the present moment.

2. *The Destruction of the Enemy's Aircraft.*—It has already been proved possible to fire a rifle, a machine gun, and even a 1-pounder gun from an aeroplane with fair accuracy, and it therefore seems logical that if two rival forces are equipped with aircraft, these aircraft must fight in order to maintain for themselves the advantage of being able to reconnoiter. The aeroplane of the immediate future will be armed, but the additional weight and strength involved entails loss both of speed and climbing power; so that, at the present, the armed aeroplane must be somewhat inferior in performance to an unarmed one, other things being equal. From an offensive point of view, an aeroplane may attack hostile (*a*) airship, (*b*) aeroplanes, and (*c*) aircraft on the ground. The average aeroplane is faster than the average airship, and therefore fighting is sure to occur so long as aeroplane pilots are determined to attack the airship. The aeroplane can fly faster, climb higher, and is easier to maneuver than the airship, while the latter can climb faster, and provides a steadier platform for a heavier armament than the former. It seems probable that airships will try to keep aeroplanes at a distance by virtue of their power to deliver more accurate fire, while the aeroplanes will endeavor to close in order to make use of their maneuvering power and to obviate the comparative inaccuracy of their fire. It may prove necessary to employ three or four aeroplanes, armed with machine guns, light guns, or bombs, for the attack of one airship. There is also the possibility of the fast aeroplane's catching and ramming or driving through the airship. This would be desperate work, but the destruction of two or three airships in this way would have a very great moral effect on the remainder. The combat between two aeroplanes is more difficult to imagine. If each was determined to destroy the other, the pilots presumably would maneuver so as to prevent the opponent using his weapon to the best advantage, while he gave his own companion the free use of his. If one aeroplane tries to avoid the other, then speed would be the determining factor as to whether they come to grips or not; but the pilot who decides to flee will, in doing so, present the best possible target to the pursuer. As has been stated, other things being equal, an armed aeroplane will always be less efficient in speed and climbing power than a similar machine not intended for the carriage of weapons, and therefore it will be difficult for the former to catch the latter, so it may be necessary to allot a definite area to an armed aeroplane, over which it would cruise and drive away any hostile scout that came into its zone. With such a scheme, encounters would be fairly frequent, and it may prove necessary to obtain command of the air before aerial reconnaissance is resorted to.

Aeroplanes and airships on the ground and their shelters can be seen from a great distance, and offer a very fair and defenseless target for attack; and the sudden attack of three or four aeroplanes provided with bombs and flying low might cause great damage to both, against which anti-aircraft guns would probably have to be employed.

3. *The Attack of Troops, Ships, and Important Buildings.*—At present it is unlikely that many aeroplanes can be used for the attack of troops on the ground.

* The tenth of the series of special lectures arranged by the Military Education Committee under the authority of the Senate of the University of London.

Until fighting in the air had come to an end, and until all necessary reconnaissance had been completed, it would hardly be sound to devote much energy to such an object, while the damage done would probably be too small to justify the risk of venturing within decisive rifle range. On the other hand, at the end of a hard fought action, *if* any armed aeroplanes were still available, which is doubtful, they would certainly assist in completing the demoralization of a beaten army. The attack of big guns, magazines, and oil tanks will, however, be a part of an aeroplane's duties in the attack of a fortress.

It is impossible to include all the desirable qualities in one type of aeroplane and, at present, it is desired to confine the requirements of the army to five types, which are as follows:

(I) The high-speed single-seater scout of exceptional climbing powers for long range reconnaissance in any wind, and of such an efficiency as to be able to escape from any type of fighting machine which it may be possible to produce at present.

(II) A speedy two-seater reconnaissance machine suitable for deliberate long range reconnaissance and capable of carrying an observer and a wireless installation. Such a type could also be used for bomb dropping.

(III) A two-seater reconnaissance aeroplane having an exceptionally good field of view and the ability to land anywhere, which will be especially suited for short range reconnaissance during the actual battle and for observation of artillery fire.

(IV and V) Finally, two fighting machines, one to carry a machine gun and the other a light gun, firing shell, both of them tentative, but both well within the range of possibility at the present moment.

The ideal would be to standardize in each of these types; but even this is impossible, as every really promising design must be given a trial, and every promising constructor must be given work.

It seems that the use of the aeroplane for reconnaissance cannot fail to hasten the progress of operations, at all events between two determined opponents who understand the value of the offensive. Fighting in the air will probably demand a higher standard of *morale* throughout those engaged in it than any other feature in war, and an aerial service which is lacking in this respect will speedily vanish from the air in the face of opponents who have it.

The aeroplane has depended almost entirely on its warlike capabilities for its development, and all those who object to a large expenditure on so warlike a service should remember that every penny which is put into military aviation is not only providing an insurance against war, but is developing the luxurious flying machine of the future.

The geographical position of any nation will no longer offer the same advantages, or disadvantages, as it does to-day. From now onward, the struggle for aerial supremacy, be it commercial or military, will go on irresistibly; new developments are following one another in hot haste, and a great nation like our own will only be able to keep her place in the race by the unflinching expenditure of money and sacrifice of life.

The Action of the Control Organs of an Aeroplane in critical attitudes

THE two main problems which confront the aeroplane constructors are:

First. To design machines capable of carrying their load with a small expenditure of power, while at the same time having motors capable of developing two or three times, or even four or five times, as much power as is required for ordinary flight. These qualities are obtained by reducing the passive head resistance to a minimum, by refining the lines of the machine generally, and by giving the wings the best possible section.

Second. To bring out machines possessing a good stability in the air, and having control organs which are effective in all conceivable positions of the machine.

In this lecture I propose to deal with the study of the forces to which aeroplanes are subject, and the way of modifying the points of application of these forces by means of rudders, elevators, and *ailerons*, in order to right a machine which has been thrown out of its normal attitude of flight.

The frequent accidents tend to give one the impression that the equilibrium of an aeroplane is very precarious, and that once the machine gets past certain attitudes the pilot is unable to control it and thus prevent a fatal accident. Is it true that these critical attitudes are so dangerous? Evidently not, for aviators like Pegoud, Chevillard, Garros, etc., have proved by actual experience that a machine can occupy all conceivable positions and yet be righted with ease. The critical conditions are: 1, Too low speeds; 2, too high speeds; 3, sideslips and dives.

1. *Too Low Speeds.*—When an aeroplane loses its speed the reaction of the air on its planes is insufficient to support it in spite of the increased angle of incidence. For angles of incidence of from 15 degrees the lifting forces do not increase with the angle of incidence, and for angles from 20 degrees they decrease. Generally when an aeroplane loses speed it turns over either to the right or to the left. This is what is called a sideslip. If the pilot tries to right his machine by warping he will only increase the sideslip, and if his motor is failing he can only right the machine by diving it until it has regained its flying speed. If the motor possesses great reserve power it is possible to right the machine before the sideslip has become very pronounced. While this sideslip is, of course, dangerous when the machine is close to the ground, there is little or no danger when it is flying at an altitude sufficiently high to allow of regaining its speed by a dive. Besides, a machine with a proper *empennage* will not lose its speed unless the pilot wishes it to do so, and it does not seem necessary to fit an automatic control organ for the purpose of helping the pilot. It is, however, always advisable to fit speed indicators which will keep the pilot informed as to the behavior of his machine.

2. *Too High Speeds.*—It is generally admitted that the conditions of too high speeds present a certain danger. It has been said that aeroplanes flying at very small angles of incidence may, by a sudden longitudinal swerve or dive, receive a sudden pressure on top of their wings, and thus losing all sustentation, they fall.

The point to be studied with regard to high speeds is: How do the points of application of the forces to which an aeroplane is subject vary for possible variations in the angle of incidence during these high speeds? Experiments with scale models in the laboratories are very instructive, and it has been possible to verify that certain machines with too deeply cambered wings, or with insufficient *empennage* or badly adjusted, may become unstable when flying with very small angles of incidence. It should be remembered that for a cambered plane the center of application of the resultant of the forces acting on it travels backward, progressively, as the angle of incidence decreases, and that for very small angles of incidence the travel of these centers in considerable.

At the Eiffel laboratory a series of experiments have been commenced with scale models of aeroplanes flying with the most critical angles of incidence by placing them in the air current, and the interesting results obtained lead to the conclusion that it is easy to design machines which the pilot can always right by means of the control organs.

3. *Sideslips and Dives.*—A fall started either by side-slipping or stalling always terminates, if the machine has a suitable *empennage*, in a vertical nose dive. The study of forces, acting on scale models, shows that even from this attitude the machine may be righted by suitably operating the control organs. The most important thing to observe is that the pilot is not thrown out of his seat, and that, thanks to an efficient safety belt, he is able to operate his controls, whatever the attitude of his machine.

Suppose that a machine through some cause or other is making a nose dive, and that the pilot is strapped in his seat. He finds that he is unable to right the machine by operating his elevator—such a contingency often occurs, and many pilots have experienced it. The thing to do in a case like that is to push the rudder over as far as it will go, for instance, to the right, in order to make the machine turn to the right with relation to its vertical path of flight, and at the same time warp the wings so as to make the machine revolve around its longitudinal axis after the fashion of the hands of a clock. The aeroplane will then right itself by describing a spiral similar to those favored by certain pilots in their exhibition flying.

* An abbreviated translation, made by *Flight*, of a lecture by M. Louis Bréguet to the Société Française de Navigation Aérienne.

The Swiss National Exhibition at Berne

The Year 1914 Marks the Fourth Exposition of This Kind in History

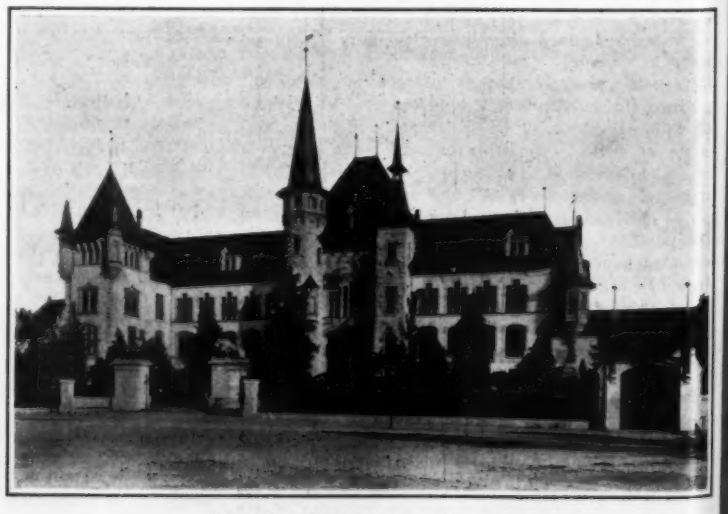
THE Swiss National Exhibition which is held in Berne, the country's beautiful capital, up to October 15th next, had a brilliant opening on May 15th, and it is anticipated that it will be the rendezvous of thousands of representatives from all lands and all nations.

Switzerland has only arranged two national exhibitions so far: one at Zürich in 1883 and another at Geneva in 1896. While the progress and development achieved during the interval between those two exhibitions are pronounced as altogether wonderful for a country with limited resources, the reports about this present exhibition indicate that it will be a revelation even to those who know the country intimately.

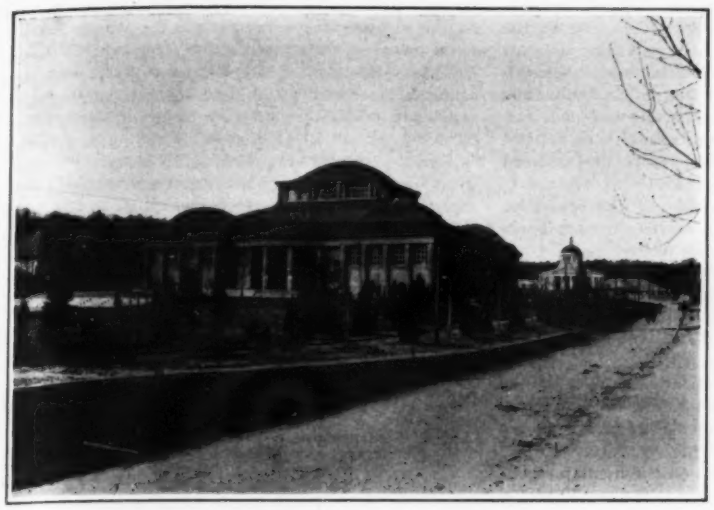
The exhibition contains seven main sections:

1. Agriculture and Mining.

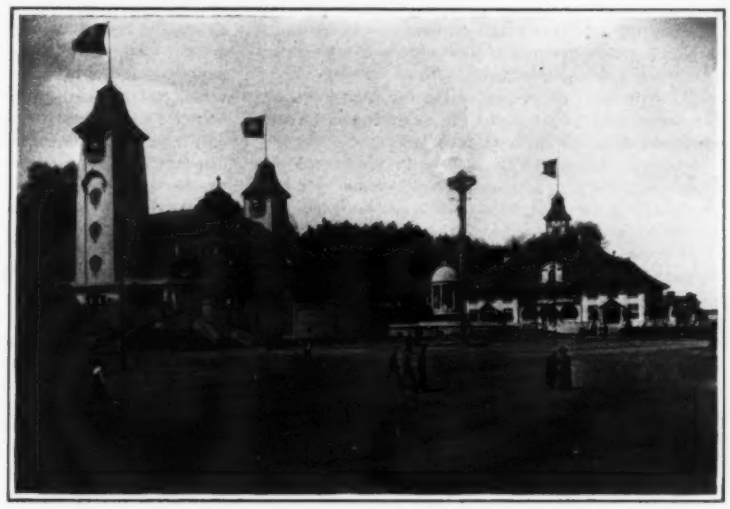
The tower of the Cathedral of Berne, seen from the River Aar.



The Historical Museum at Berne.



Military Pavilion and International Bureau in the Neufeld section of the exhibition grounds.



The principal restaurant of the exhibition, "Studerstein," on the left, and the building Hospes on the right.

2. Trades, Industries and Engineering.
3. Commerce and Traffic, including Sports and Touring.
4. Political Economy and Public Welfare.
5. National Defence.
6. Arts and Sciences.
7. International Bureaus.

The site of the exhibition is on an elevated plateau to the northwest of Berne, on the borders of the Bremgarten Forest. It is open to the east and south, and commands from every part a wonderful view of the Bernese Oberland. The area of the exhibition grounds measures some 500,000 square meters, of which 135,000 are covered with the buildings, while the remainder of the site is laid out in such a way as to harmonize with the neighboring forest.

An electric railway circulates over the whole of the exhibition grounds, which are divided into three fields: The Neufeld, the Mittelfeld, and the Viererfeld.

The Neufeld is the largest section of the exhibition grounds, and, in a technical point of view, the most interesting, for here we find: Architecture and Decorative Art, Textile Industry, Watches, Precious Stones and Metals, Musical Instruments, Paper Industry and Graphic Art, Chemical Products, National Defence, Education, Administration, Hygienics, International Associations, Gas and Water Service, Sewerage and Town Cleaning, Means of Transportation, Public Conveyances, Civil Engineering and Machinery.

A very comprehensive exhibition covering Railway Rolling Stock, with the Swiss Federal Railroads as the largest exhibitors, of course, is already exciting the interest of railroad men. Among other exhibits is the first locomotive (now about seventy years old) ever used in Switzerland, side by side with the newest and most modern locomotives employed for express trains on the St. Gothard line. The new Lötschberg Railway show their 2,500 horse-power electric engines, which, being the most powerful of the kind in the world, will prove of utmost interest to technicians. The exhibits include also special invalid railway carriages, which can be used for international traffic; rotary snow ploughs, mail and luggage vans, also vans for the transport of wine, beer and meat, and other perishable articles or goods which must be kept cool.

A typical Bernese Châlet at Interlaken.

A passageway leads from this exhibition to the Machinery Hall, the most conspicuous building on the whole exhibition grounds. It covers about 18,000 square yards and is the largest existing iron construction in Europe.

In this part of the exhibition it is possible to realize the use to which the water-power of Switzerland is now systematically put. Some of the Swiss engine and machinery makers are known throughout the world, notably those of Baden, Oerlikon near Zürich, Winterthur and Schaffhausen, and all are showing interesting machinery here at work, in charge of skilled mechanics. The necessary electric power is furnished in the building.

The Machinery Hall has two galleries reached by electric elevators. The machinery exhibited includes steam and water turbines, pumps and mechanism used in the preparation of food products, also a Diesel oil engine. There are two main divisions in the Hall, one for high-current and the other for low-current machinery. The exhibits of the Association of Swiss Electro Technicians and of the Swiss Electricity Works are under the same roof, Switzerland being one of the foremost countries in the application and knowledge of electricity.

Wireless Telegraphy*

A Comprehensive Review of the Various Systems

By H. Fothergill

SPARK SYSTEMS.

Damped Electric Waves.—The simplest way of signaling is by means of damped electromagnetic waves, and these can be easily produced by a spark coil or transformer having its two high-tension terminals connected respectively with an aerial wire and with the earth, a spark gap being placed between the connections in the manner illustrated diagrammatically in Fig. 1. The current through the primary circuit of the coil is controlled by the key *K*, so that by holding down the key for long or short periods, long and short series of waves can be transmitted corresponding to letters which are represented by the dots and dashes of the Morse code. The high-tension current charges the aerial wire until the charge increases to such an extent that it sparks across the gap, and the aerial discharges itself to earth, the strain being broken down and a wave given off. The aerial, however, not only discharges itself, but, as it were, overdischarges itself. The current rushes back again over the spark gap and charges the aerial. This oscillatory flow backward and forward between the aerial and the earth occurs a number of times until the energy is dissipated partly by radiation and partly by resistance and other losses, and insufficient remains to maintain the spark across the gap. The coil then charges the aerial again, and the same action is repeated.

The charge which can be given to an aerial wire is limited by the capacity of the wire, which is usually very small. Moreover, the aerial wire in Fig. 1 not only forms the charging circuit, but the radiating circuit, and the arrangement results in the production of highly damped oscillations, which soon die away. A good oscillatory circuit should be a bad radiating circuit, so that the charge will continue to oscillate for some considerable time before being wholly dissipated. To meet this requirement the oscillatory circuit is constructed by the Marconi Company of London and by the Telefunken Company of Berlin, as a separate circuit, and is coupled to the radiating circuit wherein slightly damped oscillations are produced, and which, when impinging on a distant receiver, create a cumulative effect that is very desirable.

The Marconi System.—Fig. 2 shows diagrammatically a popular arrangement of the Marconi system. The electric current is generated by an alternator and passed through the primary coil of a low-frequency, iron core transformer by which its voltage is increased to that required for charging the condenser in the oscillatory circuit. "The low-frequency or alternating circuit includes additional inductance either in the transformer primary or secondary circuit adjusted so that the natural period of the alternator-transformer-condenser circuit corresponds with the alternator frequency; this adjustment is provided so that the condenser charging current may be about zero value when the condenser is about to discharge." The oscillatory circuit comprises a condenser, the primary coil of a high-frequency air-core transformer, a variable inductance for altering the wave-length, and a disk discharger by which the condenser is discharged. This discharger consists of a revolving toothed wheel placed between two stationary teeth, so that every time a pair of teeth comes opposite the stationary teeth the current sparks across and the condenser is discharged. The time of charge corresponds to a half cycle of the alternator, and to the period elapsing during which there are no moving teeth opposite the two stationary teeth, the voltage or pressure to which the condenser can be charged depending on the amount of energy which can be stored in the condenser during the time of charge.

The radiating circuit in Fig. 2 includes the secondary coil of the high-frequency transformer by which energy is absorbed from the oscillatory circuit and radiated from the aerial wire in the form of electromagnetic waves. A variable inductance is included in the radiating circuit for the purpose of varying the wave-length so that it may be brought into tune with the oscillatory circuit. Suppose it is desired to send a signal. The sending key is pressed down, and thus allows the current from the alternator to flow through the primary coil of the low-frequency transformer, which induces a high-voltage current in the secondary coil. This high-pressure current passes round the circuit and charges the condenser, which is periodically discharged, say, 450 times per second, by the revolving toothed wheel. Each condenser discharge produces a group of electric oscillations in a manner similar to that described with reference to the discharge across the spark gap in Fig. 1. These oscillations, by passing through the high-frequency transformer, induce oscillations in the radiating circuit which alternately charge the aerial wire in opposite directions, and in so doing produce electromag-

* Abstract published in *The Engineer* of paper read before the Northeast Coast Institution of Engineers and Shipbuilders.

netic waves which are propagated outward in all directions over the surface of the earth. It will be noted that choking coils are placed between the low-frequency transformer and the oscillatory circuit. These are inserted for the purpose of preventing the high-frequency oscillations from passing into the low-frequency transformer and doing possible damage.

Telefunken System.—This system is illustrated diagrammatically in Fig. 3, from which it will be seen that it is similar to the Marconi system; the two companies, however, agreed upon terms which avoided litigation. The principal differences between the two systems are the method of discharging the condenser and the method of producing oscillations in the radiating circuit. The discharger, which is illustrated diagram-

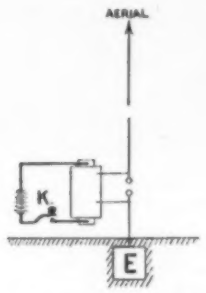


Fig. 1.—Plain aerial.

matically in section in Fig. 4, consists of circular plates of copper separated from each other by mica distance-pieces of about 2 millimeters in thickness. The spark forms at any point on the flat surface of the plates; it is then forced toward the periphery in a radial direction by the electromagnetic field, and is eventually extinguished on its path by a circular groove which the spark cannot bridge. Between each pair of plates is a large disk of thin copper, which is effective in radiating the heat generated by the spark. Short-circuiting plugs, which can be inserted between the copper disks, are provided in order to short-circuit as many gaps as may not be required. The quenched spark discharge may thus be adjusted to suit the voltage, and consequently permit of variations in the power utilized. For example, if small power is required a number of gaps will be short-circuited, and the alternator voltage reduced; if full power is required, all the gaps will be opened and the alternator voltage raised to correspond with the number of gaps. It will thus be seen that by connecting a suitable number of gaps in series and adjusting the voltage, it is possible to keep the energy per gap from exceeding a certain value, and thus avoid overheating, which would prevent the quenching of the spark. Since the energy transmitted varies as the square of the number of spark gaps, the regulation by short-circuiting covers a wide range. Thus, if there are ten gaps and nine are cut out, the maximum energy can be reduced to 1 per cent. The pressure per gap is approximately 1,200 volts, so that if ten gaps are in use the charge given to the condenser will reach a pressure of approximately 12,000 volts before discharging across the gap and round the oscillating circuit in which it oscillates. It will be noticed that the radiating circuit is not indirectly coupled to the oscillatory circuit, as in the Marconi system, but is directly coupled by what may be called an auto-transformer, consisting of a copper helix, one part of which is included in the oscillatory circuit, the other part forming a portion of the aerial or radiating circuit.

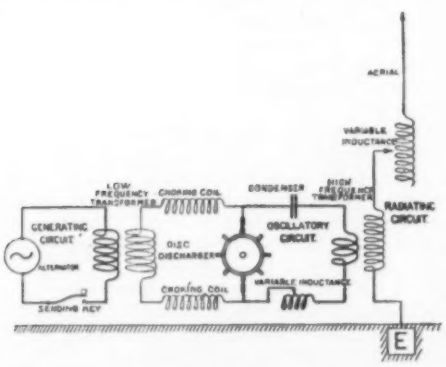


Fig. 2.—Marconi system.

The action of a coupled circuit transmitter, whether on the Marconi or Telefunken system, is less simple than would appear at first sight. It might seem natural to suppose that the oscillatory circuit is unaffected by the radiating circuit, but this would be an incorrect assumption, because, just as the currents flowing to and fro in the oscillatory circuit induce similar oscillations in the radiating circuit, so do the induced currents oscillating in the radiating circuit tend to react on the oscillatory circuit. Thus when the oscillatory circuit has given up its energy to the radiating circuit, the latter circuit rebounds, as it were, and starts giving back some of its energy to the oscillatory circuit. One circuit reacts on the other till the oscillations induced alternatively in each circuit die away or are drowned by the violent oscillations which are being frequently produced with maximum amplitude by the condenser discharges. This action of the energy swaying backward and forward from one circuit to the other is illustrated graphically by Fig. 5. The upper curve represents the oscillatory circuit and the lower curve the radiating circuit. It will be seen that the oscillatory circuit commences with a maximum amplitude which corresponds with the moment of discharge of the condenser, and that the oscillations are absorbed by the radiating circuit, in which the induced oscillations are of maximum amplitude when the whole of the energy has been absorbed by it from the oscillatory circuit. The radiating circuit then reacts on the oscillatory circuit, with the result that instead of the whole of the energy remaining in the radiating circuit and being dissipated in the form of electromagnetic waves, it is partly wasted in uselessly exciting the oscillatory circuit. This exchange of energy continues until the whole of the energy is dissipated or radiated from the aerial wire. The entire effect extends over only a fraction of a second, and is equivalent to the time during which each spark occurs at the discharger.

If a Marconi revolving disk discharger is suitably designed and run at a predetermined speed, the period during which two moving teeth are passing the two stationary teeth, is equal to the period during which the whole of the energy is originally transferred to the radiating circuit; and as the spark is then extinguished, the teeth having moved on, it is impossible for the energy in the radiating circuit to flow back into the

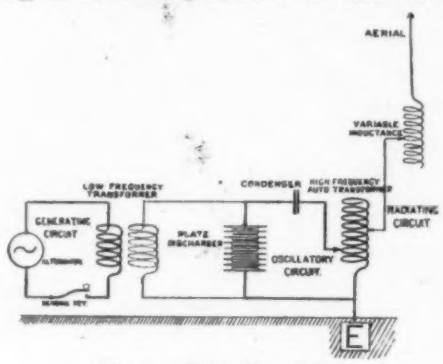


Fig. 3.—Telefunken system.

oscillatory circuit. The result is that the oscillations continue in the radiating circuit with a steadily decreasing amplitude. During this time the condenser is again being charged ready for discharge by the next two moving teeth, which pass the two stationary teeth, when a new series of oscillations will be induced in the radiating circuit. This true effect is obtained with disks running with high peripheral speed, and working with long waves and loose coupling, as the disk may then be arranged to cut off a discharge or spark before any material part of the energy communicated to the aerial is returned to the oscillatory circuit.

Undamped or Continuous Oscillations.—An undamped or continuous oscillation is one which oscillates continuously with the same amplitude. At present there are two notable systems which produce undamped or continuous waves; they are the Goldschmidt and Poulsen.

Goldschmidt System.—In theory this system approaches very closely to the ideal; but so far it has been unfeasible to carry out in practice what appears so desirable in theory. Theoretically, the system consists of an alternator which produces an alternating current having a very high frequency, the frequency corresponding to the frequency of the oscillations that it is desired to produce in the aerial wire. To understand why such a system is impracticable for commercial use, that is, for from ship to shore signaling, it will be necessary to consider the construction of an alternator. It should first be stated, however, that, according to international law, the wave-length used on ship stations must measure either 300 meters or 600 meters, the ability to radiate a 300-meter wave being compulsory, but the use of a 600-meter wave is optional. Therefore, in order to be suitable for use on shipboard the alternator must be able to produce oscillations which will give a 300-meter wave.

Now, it is easy to show that a 300-meter wave corresponds to 1,000,000 oscillations per second, and therefore the frequency of the alternations in the current produced by the alternator must equal 1,000,000 per second. Usually the frequency of an alternator depends on the revolutions per minute and the number of magnetic poles. Even supposing the periphery of its moving part were divided into 100 poles, which is a large number, the speed would need to be 1,200,000 revolutions per minute in order to obtain a frequency of 1,000,000 per second. This speed is, of course, obviously impossible. However, according to a special arrangement of Goldschmidt's, the magnetic field of his alternator is rotating, not mechanically, but electrically,

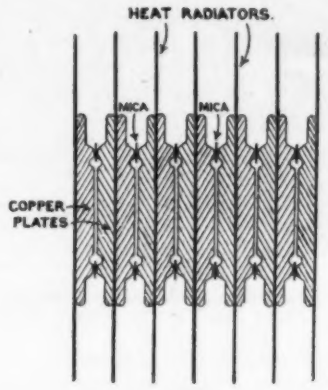


Fig. 4.—Discharger.

while at the same time the armature is rotated mechanically in the field in the opposite direction. The result of this is the production of a frequency depending on the sum of the rates of rotation of the magnetic field and of the armature; and current at this higher frequency is carried back to the field and produces a more rapidly rotating field than the first. To this, again, is added the frequency produced by the rotation of the armature. This process is repeated several times until the required high frequency is reached. In theory it is feasible, but in practice the complications and loss of energy at each step are so great that the inventor has not yet exceeded a frequency of 40,000 per second, which is a long way short of 1,000,000, the frequency required for the 300-meter wave. The system is therefore unsuitable for short wave-lengths, and is not likely to come into use for from ship to shore signaling.

Let us consider, then, whether or not it is possible to use such an apparatus for long wave-lengths, such as are used in high-power long-distance stations. The wave-length corresponding to a frequency of 40,000 per second would be 7,500 meters in length, a wave-length which has been frequently used, and therefore the system could be employed for long distance signaling, but apparently from the negotiations between the Postmaster-General and the Goldschmidt Company in Germany, the system has not yet proved itself reliable. From the information available it seems as if Goldschmidt proposes to use for transatlantic signaling a 500 horse-power steam engine driving two dynamos of nearly 200 horse-power each, the armatures of these machines being connected to a motor that drives the high-frequency alternator, the rotating part of which has no fewer than 384 poles. It would seem that the general plan adopted in damped wave systems of driving the whole of the moving plant direct on one shaft from a steam turbine is more simple and desirable.

Poulsen System.—Nearly fourteen years ago it was shown by Mr. W. Dudell, the past president of the Institute of Electrical Engineers, that when an electric arc between two solid carbon rods, as in a street arc lamp, is shunted with a condenser and inductance in series, electric oscillations are set up in the condenser circuit. In 1903 Valdemar Poulsen of Copenhagen described important improvements in this method of creating electric oscillations. He produced an electric arc between a carbon rod and a copper rod which was kept cool by water circulating within it (see Fig. 6). The arc was at the same time surrounded by an atmosphere

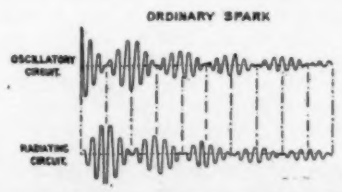


Fig. 5.—Sway between oscillating and radiating circuits.

of hydrogen or a hydrocarbon gas or vapor, and crossed transversely by a strong magnetic field. This arc formed part of an oscillatory circuit, including a condenser and a primary coil of a high-frequency transformer, the secondary of which formed part of the radiating circuit.

It is characteristic of an electric arc that as the cur-

rent increases the potential difference of the carbons decreases, or, in other words, the more current that is passed through the arc the less is the pressure difference between the carbons. Now let it be supposed that the arc be burning steadily, and the oscillatory circuit is applied to it, electricity rushes into the condenser, and while it is being charged the current through the arc is diminished. The pressure difference across the arc is therefore increased, and the tendency is to charge the condenser still further. When the condenser is fully charged the arc current again slightly increases, and thus causes a reduction in the pressure difference across the arc. This reduction in pressure allows the condenser to discharge itself across the arc, thus increasing the arc until the maximum current is reached, when the cycle recommences. These rapid condenser discharges produce oscillations in the radiating circuit, which are sustained by the condenser alternately drawing current from the arc and then giving it back again at the moment of discharge, the result being the production and radiation of persistent or undamped waves.

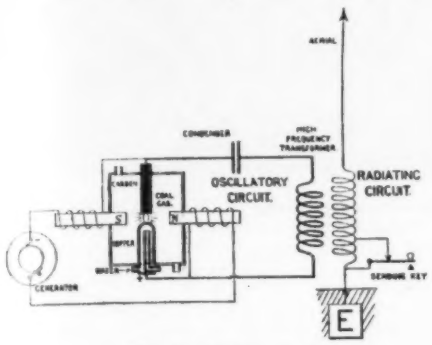


Fig. 6.—Poulsen system.

If an arc of this description could be constructed of such a size that it could deal with sufficient energy for long-distance signaling, and provided the arc could be maintained in a stable condition, then there seems to be no reason why such a system should not become popular, even though its efficiency is very low. But the arc does not remain steady, and it would seem unreasonable to expect it to do so. Its instability is caused by the carbon electrode, which is continually burning away, and this tends to keep the actual length of the arc in a state of variation which cannot be avoided even by the feeding mechanism provided. This variation in the arc results in a variation in the current flowing across it, which also means a variation in the charge given to the condenser, and a consequent variation in the strength of the waves emitted. The seriousness of a weakening in the waves transmitted will become at once apparent when it is realized that if the strength of the waves is suddenly decreased, as the result of a variation in the arc, the reception of the signals at the receiving station might be rendered inaudible, and probably the whole of the message would need to be repeated. The most serious objection to the Poulsen system is not, perhaps, the weakness of radiation, but the variations in the length of the waves transmitted, which result in the signals disappearing at the receiving station owing to the transmitter getting out of tune, or result in the signals inverting: that is, spaces coming through as signals instead of the dots and dashes, owing to the spacing signals getting in tune with the receiver.

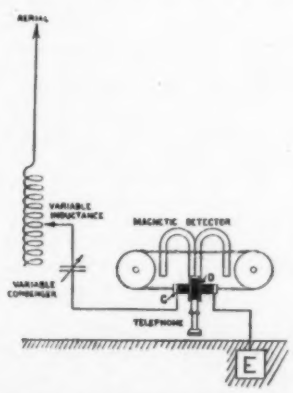


Fig. 7.—Simple receiving circuit with magnetic detector.

RECEIVING ELECTROMAGNETIC WAVES.

An aerial wire absorbs some of the energy of electromagnetic radiation falling upon it, and it absorbs best radiation of that kind and wave-length which it would itself emit if set in oscillation, and absorbs it most readily when arriving in the direction in which it would itself radiate most strongly. The length of an electromagnetic wave depends on the oscillation constant of the circuit, and the oscillation constant depends on the capacity of the condenser and the quantity of inductance in the circuit. Therefore all receiving stations should have embodied in their circuit a variable inductance and a variable condenser, whereby the circuit may be tuned to receive the waves radiated from the transmitting station.

The oscillations produced in a receiving circuit by the waves impinging on the aerial wire to which it is connected are not directly appreciable by our senses, and their existence can only be ascertained by the employment of detectors. When an aerial wire is to be used for receiving it may be connected directly to a circuit containing an oscillation detector, or inductively coupled to a circuit in which the detector is placed. The former and simpler method is shown in Fig. 7. Waves from the transmitting station impinge on the aerial wire, and if the variable inductance and condenser are suitably adjusted so that the wave-length of the receiving circuit corresponds with the wave-length of the transmitting circuit, then energy will be absorbed by the aerial wire and electric oscillations set up, which swing backward and forward between the aerial wire and the earth. Inserted in the circuit is a detector, which in the arrangement illustrated is of the magnetic type. This instrument is largely used by the Marconi Company, and comprises an iron band rotating in a magnetic field so as to carry the iron through a cycle of magnetic changes. When electric oscillations pass through the primary coil wound round the band, the change of the magnetic state of the iron generates an induced current in the secondary coil, and hence a current and a sound in the telephone receiver.

Fig. 8 shows an example of a receiving circuit which is inductively coupled to the detector circuit by two coils *A* and *B* so arranged that one moves axially within the other, whereby the distance between the coils can be varied. The great advantage of a coupled circuit is

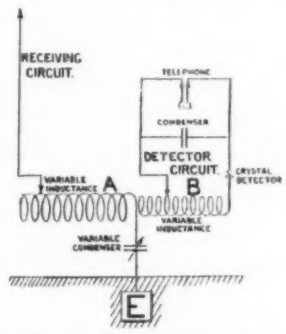


Fig. 8.—Telefunken inductively coupled circuit.

the ability to eliminate waves of slightly different wave-length, and thus promote sharpness in tuning, which is such a very desirable feature. For example, suppose we desire to pick out a distinctive station among several which may be signaling, we would first bring the coils *A* and *B* close together or slide one within the other so as to couple the two circuits tightly, and then tune the detector circuit by varying the condenser and inductance until the value of its oscillation constant approaches that of the receiving circuit, when we will hear the signals intended for us. If, however, these signals are "jammed" by signals from other stations, then the coils *A* and *B* are separated from each other and the circuits finely tuned by careful adjustment of the condensers and inductances, so that only that wave which will set the receiving circuit oscillating most violently will induce oscillations in the detector circuit. The undesired waves, which may be of slightly different frequency, will not produce oscillations in the receiving circuit of a strength sufficient to reach across the distance between the two coils *A* and *B*, and induce forced oscillations in the detector circuit.

It is obvious that this method of selectivity cannot be obtained by a simple receiving circuit in which the detector is inserted, because if the detector is reasonably delicate it is certain to be affected by all waves of approximately the same wave-length, whereas with an inductively coupled circuit only that wave having a frequency identical with the natural frequency of the receiving circuit will set the circuit oscillating with sufficient intensity to induce oscillations in the loosely coupled detector circuit.

The arrangement shown in Fig. 8 is adopted by the Telefunken Company, which employs crystal detectors of the kind shown in Fig. 9, which consist of a delicate metal contact that is pressed against a suitable crystal held in a clip or holder. The action of this type of detector is not yet thoroughly understood, but certain definite facts have been established. The oscillations induced in the circuit by the waves received are similar to the oscillations created in the transmitting circuit, and produce positive and negative currents oscillating alternately in opposite directions. Now it has been found in actual practice with crystal detectors that the current in one direction passes through the crystal between the contacts to a much greater extent than the current in the other direction, and the practical effect of this phenomenon is to separate from the oscillations

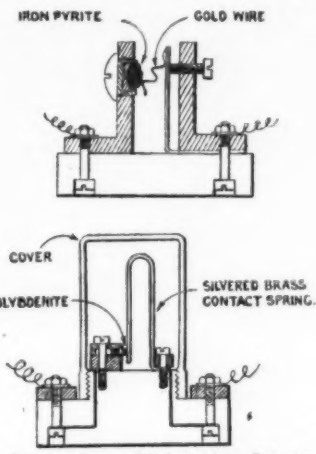


Fig. 9.—Sections of Telefunken detectors.

a direct current which passes on and produces a sound in the telephone, or may be caused to affect some other device in the circuit by which the signals can be distinguished.

Crystal detectors are also largely used by the Marconi Company, carborundum being the crystal principally employed. The arrangement adopted is shown in Fig. 10, from which it will be seen that the crystal and telephone are arranged in series with a potentiometer, whereby a small current can be passed through the crystal.

With the object of still further increasing the sharpness of tuning and selectivity, the Marconi Company employ three circuits in their receiving apparatus, an intermediate circuit coupling the receiving circuit to the detector circuit. Each circuit contains a variable condenser and inductance, so that by finely tuning the circuits to the frequency of the waves to be received, and then by moving the coils in the intermediate circuit away from the coils in the receiving and detector circuits, a very loose coupling can be effected, so that only those waves having a frequency corresponding to the natural frequency of the three circuits will be able to excite oscillations in the detector circuit. The oscillations produced in a receiving circuit by a wave of different length to that wave-length for which the circuit is tuned are termed forced oscillations; and, although these forced oscillations may exist in the receiving circuit, and may possibly excite oscillations in the intermediate circuit, they are quickly damped down and give way to the natural oscillations produced by the waves corresponding in length to those for which the circuits are tuned. Hence with the Marconi multiple tuner there is very little possibility of these interfering waves reaching the detector circuit and "jamming" the signals intended to be received. It should be mentioned, however, that interfering waves can only be excluded in the manner described when the waves themselves are sharply tuned. A wave having a flat tuning would probably break through all the circuits and might cause serious interference in the detector circuit by drowning out the signals which are intended to be received. Ac-

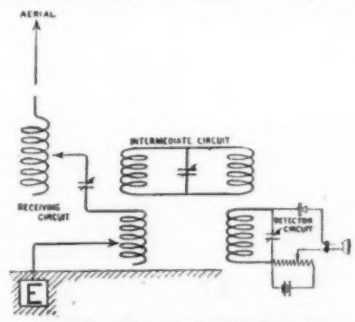


Fig. 10.—Marconi crystal detector.

cording to the law in most countries, however, sharpness of tuning in the waves transmitted from stations working on commercial wave-lengths is compulsory, and by means of this stipulation selectivity in wireless telegraphy is rendered possible. But in time of war laws are not considered, and it often proves of great value to radiate highly damped waves having a flat tuning so as to cause serious interference with the enemy's instruments and prevent the exchange of signals between their camps.

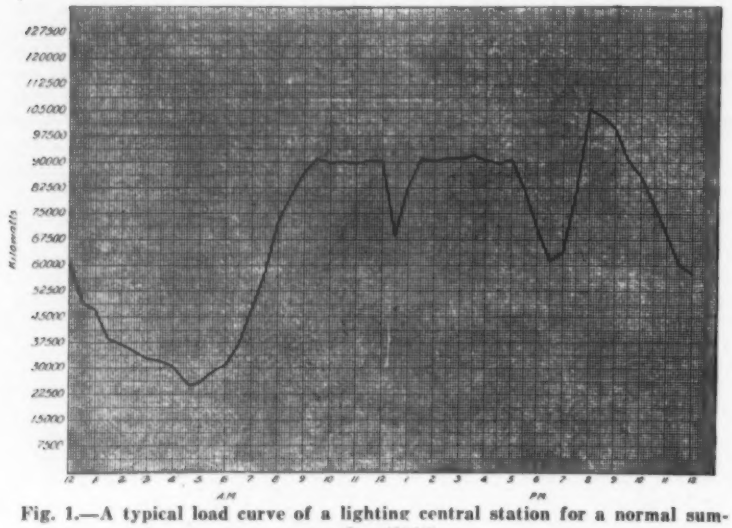


Fig. 1.—A typical load curve of a lighting central station for a normal summer day (1913).

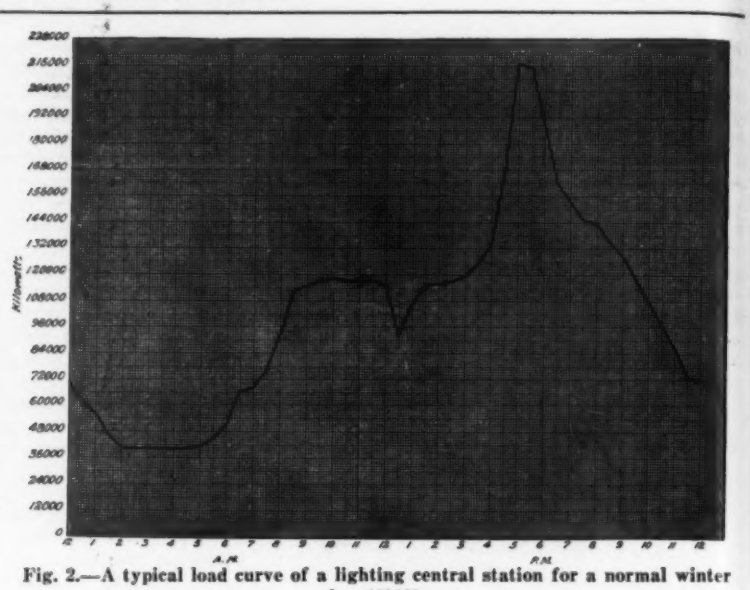


Fig. 2.—A typical load curve of a lighting central station for a normal winter day (1913).

The Storm Detector*

Its Influence Upon the Operation of Lighting Central Stations

By W. H. Lawrence

INTRODUCTION.

Such public utilities as those supplying gas and water are fortunate in that the commodities they distribute are physical materials. During those parts of the day when the demand for their product is small, the excess delivered from the station can be economically stored in a reservoir for use at later periods in the day when the demand is greater than the capacity of the station.

The public utility that distributes electricity, however, cannot be modeled profitably after this plan on account of the properties of the commodity that it handles.

Electricity, like light and sound, is not a physical material and therefore can exist only as long as the influence of its generating source continues. This property renders it impossible to directly store or preserve electricity for future use. Although such an end may be indirectly accomplished by the use of storage cells, which convert the kinetic energy carried by the current into potential chemical energy and later carry out the reconversion, the efficiency of this method is very low. For this reason, the use of storage batteries in supplementing the generation of electricity has been restricted to such purposes as involve the furnishing of a reserve to safeguard the service against interruption when some accident temporarily affects the generating, transmission or transforming systems.

Electrical stations, being unable to economically avail themselves of the use of a reservoir which may be charged with the excess energy of the station at light-load periods and discharged to assist the station at the heavy-load periods, have to be designed with a capacity equal to no less than the maximum demand upon them. This factor of an installed station capacity at least equal to the maximum peak load is the greatest financial handicap to which an electrical station is subjected. That this condition is unavoidable has long been recognized and accepted by our business men and engineers.

The variations in the load which are demanded of a lighting station during the day and the characteristic difference between the summer and winter loads are shown by Figs. 1 and 2, of which Fig. 1 is a typical load curve for a summer day and Fig. 2 one for a winter day. (A typical load curve for the month of March is shown in Fig. 3. It will be noted that the time at which the peak occurs lies between the hours of the winter and the summer peak.)

Since it is only during the peak load of the day that the whole equipment of the station is working, it is evident that the return on the entire investment during the remainder of the day must be earned by that portion of the equipment that is then operating.

This is a condition that makes it highly imperative that an electrical station be operated with maximum economy throughout the entire day. Given a certain station equipment, this is mainly accomplished by a strict adherence to a regular daily routine. Thus, at any period of the day only that number of machines is operated which is sufficient to economically carry the load then existing. At times of light load or average load, a steam-driven station will have a large share of its boilers "banked" and a number of its generating units idle. When under such a condition a large unexpected demand for an increased output may be made so suddenly that the number of machines which are operating will be insufficient to carry the abnormal demand, and it is probable that the standard of service will be lowered until such time as reserve boilers and generating units can be brought into service. For this reason it is imperative that the station receives preparatory warning of any abnormal demand.

The rapidly moving clouds which accompany a storm constitute the principal cause for the sudden and unexpected increases in the demand for current from a lighting station. The effect which a sudden and heavy storm may have upon the station's output is shown by the sharp peak at the 3:35 P. M. point of the curve in Fig. 4. This is the record of an actual occurrence which took place during the month of March, 1911. It will be noted from this curve, and by a comparison with that of Fig. 3, that the demand at 3:35 P. M. is 73 per cent greater than it would have been had there been no storm. An increase of 49,500 kilowatts, in this instance, was called for in about five minutes, which gives a good idea of the severe demands that may arise and which a lighting station must be prepared to meet.

Any device, therefore, that will provide a warning of the approach of a storm, at a time sufficiently far in advance to enable the station attendants to prepare for the exception to their daily routine in a deliberate and orderly manner, would be most welcome.

The storm detector is such a device.

STORMS AND THEIR EFFECT ON THE DETECTOR.

All summer storms, or practically all of them, are accompanied by electrical disturbances in the ether. These cover a field far greater than that over which the storm clouds themselves are visible. By use of antennæ, some of these radiations may be intercepted and by a suitable apparatus be made to give an indication of not only the presence but also the relative proximity of the storm.

The storms that occur during the winter months are usually snow storms and are of but a weak electrical nature. For this reason, they may perhaps not affect the device. At this season, that is a matter of but small moment. In winter the load upon the stations during the daylight hours is uniformly greater than during the summer, and the demand regardless of the severity of the storm will always be from 20 to 25 per cent less than the demand which occurs daily between 5 and 5:30 P. M., for which the station is always prepared.

This is evident when it is considered that winter storms have no effect on street lighting and other outside lighting, sign lighting, residence and apartment-house lighting, etc., all of which are on at the time of the daily peak at 5 P. M. For this reason, winter storms are of such minor importance that the service of the storm detector is dispensed with during that season.

DESCRIPTION OF STORM DETECTOR.

The various parts making up the detector are an aerial, a short-circuiting switch, a spark gap, a coherer, a relay and battery, a bell (which also acts as a decoherer) and battery, a condenser and a ground connection. Fig. 5 shows the diagram of connection of these parts.

Aerial.—Antennæ, similar to the more simple ones used in connection with wireless telegraph outfits, have been found to serve the purpose admirably. It is this part of the equipment that receives the ether radiations resulting from the storm.

The oscillating current thus set up travels to and from the ground through the spark gap, coherer and condenser.

Short-circuiting Switch.—This switch and its connections are shown in Fig. 5. Nominally, it is kept in the "open" position. After the alarm bell has begun to ring continuously, it is closed to protect the apparatus from heavy surges and to silence the bell.

Spark Gap.—This consists of a simple gap with spherical terminals placed approximately 1/64 inch apart. The purpose of this gap is to prevent those surges that are induced in the antennæ by the radiations emanating from wireless telegraph stations, but which are very weak as compared to the lighting disturbances, from flowing through the remainder of the apparatus and thus causing a false alarm.

Coherer.—This is also patterned after the type of the simple ones used in the early days of wireless telegraphy. In brief, it consists of a short section of glass tube of small bore loosely filled with nickel-silver filings. These are connected at each end to the outside circuit by German silver plugs. The action of such a type of coherer is well known, and needs no further explanation than to say that it acts as a high resistance to the low-voltage battery current impressed upon it until a high-frequency discharge current, between aerial and ground, has passed through it. This high-frequency current effectively lowers the coherer's resistance to the battery current, which consequently allows a greatly increased battery current to flow through the tube. The resistance of the tube then remains unchanged until it is violently jarred, at which time the high-resistance property returns.

Relay and Battery.—The most effective type of alarm is an audible one, of which the simplest form is a bell. However, as a bell requires a greater amount of current for its operation than that increased amount of battery current which is caused to flow in the coherer by a high-frequency discharge, some magnifying or relay device must be used. The relay employed is one of the ordinary telegraph type and the battery B_1, Fig. 5, is of dry cells. The connections are given in Fig. 5.

Bell and Battery.—The bell is one employing single-stroke connections and is of a size sufficient to be easily heard throughout the system operator's office. (The coherer, relay, condenser and bell are located in this office.) The bell has its own supply battery of dry cells, B_2, and is controlled by the secondary contacts of the relay, as shown in Fig. 5.

As the low-resistance condition into which the coherer is thrown by a high-frequency discharge is permanent until the tube is severely jarred, the bell is mounted so that its clapper will strike the tube and thus perform the two-fold function of bell and decoherer. (It is evident that the tube must be decohered, otherwise it would not show the effect of a later high-frequency discharge.)

Condenser.—The condenser is an ordinary one and is inserted in the ground wire to prevent stray direct current from flowing in the apparatus.

Ground Connection.—This connection completes the high-frequency circuit from aerial to ground.

* Reproduced from the *General Electric Review*.

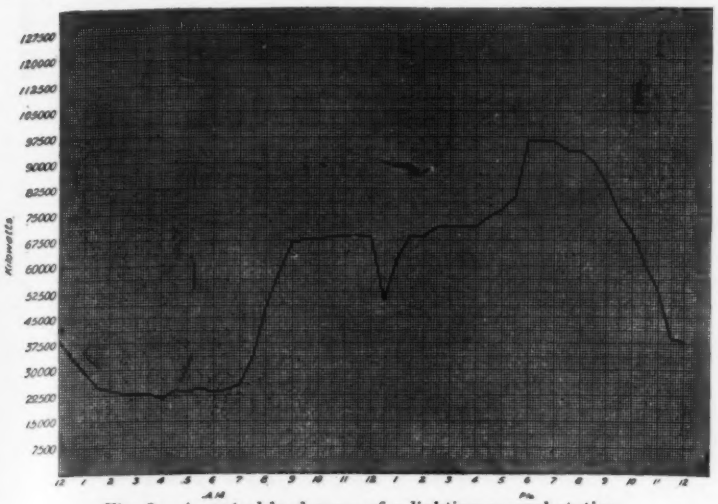


Fig. 3.—A typical load curve of a lighting central station for a normal March day (1911), when the conditions of operation were normal, and the load curve follows a regular daily cycle.

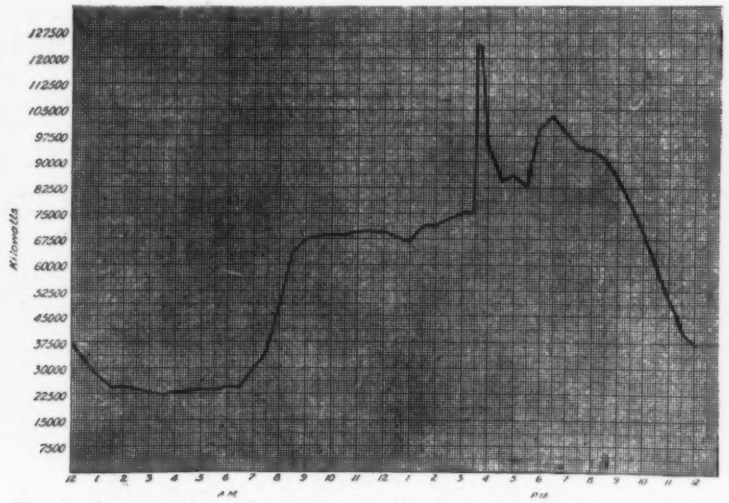


Fig. 4.—An example of a load curve of a lighting central station for a March day (1911), during which a severe unexpected storm took place at 3:30 P. M. But for the abnormal peak occurring because of this storm, the curve would be similar to that of Fig. 3.

OPERATION.

The operation of the apparatus comprising the storm detector leaves practically nothing to be desired. The manner in which it enters into the activities of a steam station will be described, as it is perhaps to such a station that it is of the most benefit.

It will be remembered that the bell or decoherer, together with the coherer and relay, are located in the system operator's office.

It is the duty of the system operator that he keep continuously posted on the demands that are or may be made upon the station for power and to so direct the disposal of all the generating machinery that the station will afford the highest quality of service and will operate with the maximum degree of economy. In detail, the latter function he performs by orders to the boiler room specifying how many boilers shall be maintained under load and how many shall be carried "banked," by instructions to the generating room as to which machines shall carry the load and which other units and auxiliaries shall be held idle or in readiness, and by orders to the various switchboard operators as to which feeders shall be used in the disposition of the output.

Under the usual daily conditions of operation the demand which will be made upon the station from hour to hour is accurately known, for the variations of the

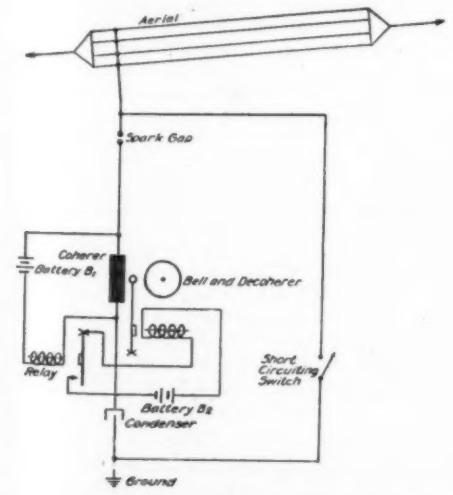


Fig. 5.—Complete diagram of connections of the apparatus comprising "the storm detector."

load curve constitute a daily cycle. These regular changes of load, being anticipated and taken care of by orders from the system operator, become a matter of station routine.

In order to secure smoothness of plant operation, the system operator is informed of the unusual departures from the regular load curve that are to be expected, e. g., exhibition lighting, etc., and also of the weather forecasts. All such is of great assistance in aiding good management. Those unusual irregularities of whose coming he is reliably warned present no difficulties. It has been found by operating experience, however, that the weather forecasts come far from providing a reliable and early warning. Further, the reports are not couched in such terms as furnish the system operator with the information that is of paramount importance to him, viz., the rapidity, in hours, of the approach of the storm.

It is true that the number of severe storms which come over a city with extreme rapidity is much less than that of the slower moving storms, but, on account of their tremendous capacity for suddenly deranging the orderly routine of the lighting station and perhaps even affecting the standard of its service, the fast moving storms make it requisite that all are to be guarded against.

Assume, for instance, such a storm to be approaching a city in which is located a lighting station that possesses a storm detector.

At a time varying from two hours to seven hours before the actual storm clouds reach the city (depending upon whether the path of the storm is a direct or a roundabout one), the alarm bell will begin to strike at intervals of from five to fifteen minutes. The system operator regards this merely as the warning of the possible approach of a storm but gives it no further attention, for the storm may change its direction and pass off without molesting the quiet weather conditions of the city.

The disturbing conditions by their further approach cause the bell to ring oftener. With the storm but about two hours' travel away, the bell will strike about once every half minute or every minute. When this occurs the system operator orders the reserve boilers into service, the auxiliaries of such generating units as he deems may be required started, and the generating units themselves run at low speed.

These conditions prevail until that later time when the bell gives an insistent warning by uniting its periodic strokes into a continuous ringing. This will ordinarily occur at about one half hour to one hour before the storm reaches the city. It has been found quite often that even at this time the sky will remain clear and unclouded to the eye, which shows how much superior are the services of a storm detector to those of a watchman stationed upon the roof to observe the conditions prevailing in the sky. (This latter practice was the best one available prior to the development of the storm detector.) The switch short-circuiting the detector is closed when the bell begins to ring continuously to protect the receiving apparatus, for the storm will now be comparatively close, and to silence the bell, for its warnings are no longer needed, since it is positively known by this time that the coming of the storm is a certainty. Simultaneous with this action goes the order to synchronize the incoming generating units with the bus. Everything is now in readiness to supply the increased load which will be demanded in but a matter of minutes.

The following are actual records of the frequency of the bell warnings and the loads existing at various times preceding two storms last year.

July 28.

1:45 P. M.....1 bell.
2:15–3:30 P. M.....1 bell every ½ to 1 minute.
3:30 P. M.....bell began ringing continuously, load 96,000 kilowatts.
4:15 P. M.....(very dark, heavy rain storm), load 142,500 kilowatts.

August 1.

8:25 A. M.–2:00 P. M...1 bell every 3 to 5 minutes.
2:02 P. M.–2:15 P. M....1 bell every ½ minute, load at 2:00 P. M., 100,000 kilowatts (cloudy).
2:15 P. M.–3:20 P. M....bell ringing continuously.
3:45 P. M.....load 150,000 kilowatts.

APPLICATION OF THE DETECTOR.

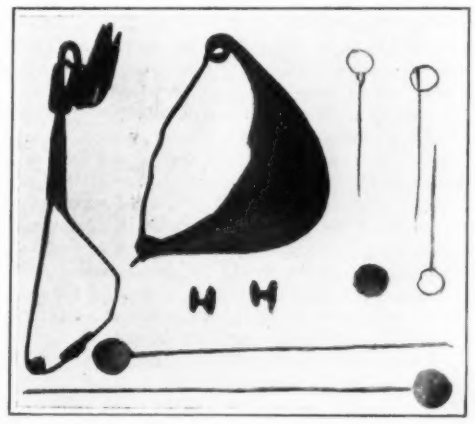
The storm detector as described is in service and located in the office of the system operator in the waterside stations of the New York Edison Company. These stations, so far as it is known, are the only ones possessing a device of the same nature.

The field for such a device among steam-driven lighting stations would seem to be in the larger cities, particularly in those which possess crowded office districts, as it is the load derived from such a source that is most sensitive to changes in daylight.

A field in which it would also seem that the device would furnish valuable service is that of keeping the isolated hydro-electric station informed as to the weather conditions existing in the distant cities which it is supplying with lighting current. The places of generation and consumption being so far separated, a visual observance of the weather conditions at the power plant would be of no use. By means of storm detectors located in a few of the widely separated towns which receive lighting current from the station, the attendants may keep forewarned by a bell in their station as to the irregular demands which may be made on them by storm clouds passing over those distant towns.

The Antiquity of Some Common Articles of Apparel

THERE is nothing new under the sun; not even a collar stud. It may be rather surprising to the reader that the Romans possessed collar studs, for whoever saw a Roman wearing a collar? The fact is, he did not use the stud to fasten his collar, but perhaps to hold



Safety pins, clasps, "collar studs" and hair pins of Roman antiquity.

together other garments, and, incidentally, he also applied it to an entirely different purpose, namely, as a caster for chair legs, etc., somewhat after the manner of an article known on the market to-day as "domes of silence." Other articles which have been found among Roman relics are various forms of safety pins, and some hair pins fashioned like the hat pins of to-day. There were also clasps in use which seem to have served to fasten a bouquet to the Roman ladies' dresses.

For Shunting Purposes at the Cleveland ore docks, with a view to avoiding the inclusion of the shunting engine among the cars being shunted, the Pennsylvania Railway has introduced locomotives which have the peculiarity that they do not run on the same lines as the cars they handle, but on a narrow gage parallel line. Each engine has an arm on each side which can be lowered by means of compressed air controlled from the cab, and acts as a pusher. The locomotives are of Baldwin-Westinghouse make, and are 25 tons in weight. Power is obtained from two rails lying inside the rails on which the locomotives operate; these rails are protected by a wood covering.

The Preservation of Wood—II*

A Synopsis of the Principal Processes in Use To-day

By A. J. Wallis-Tayler

Continued from SCIENTIFIC AMERICAN SUPPLEMENT No. 2012, Page 54, July 25, 1914

The Dead Oil of Tar Process or "Creosoting."—John Bethel evolved in 1838 a practical process for the injection of hot creosote oil, or dead oil of tar, into wood to be preserved, the operation being performed in a closed vessel or retort under pressure. This process is now universally known as "creosoting," which, however, is a misnomer, as dead oil of tar or creosote oil actually contains no real creosote.

The substance owes its success as an antiseptic agent to the presence of insoluble non-volatile substances in-

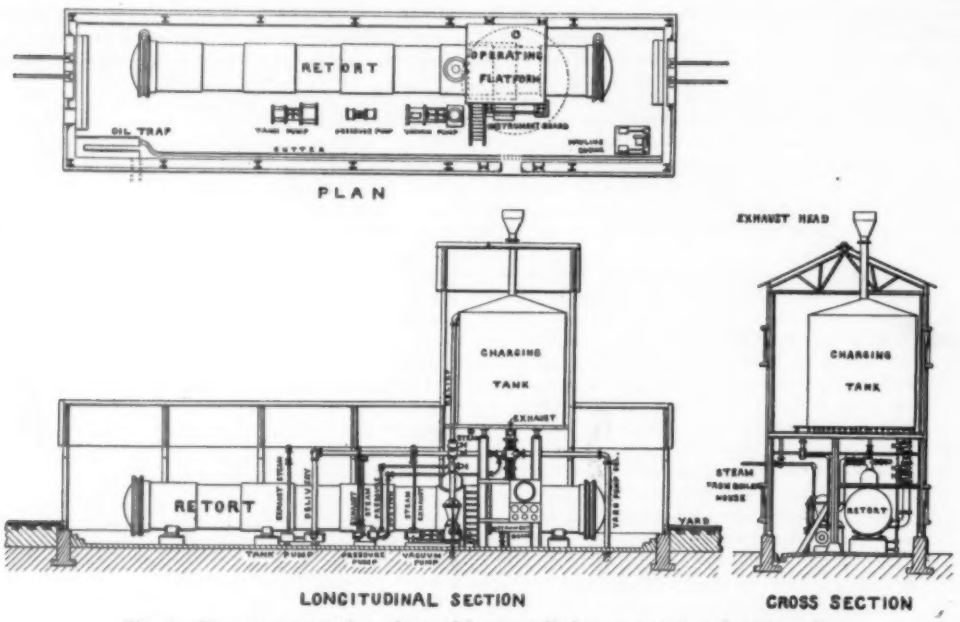


Fig. 8.—Pressure creosoting plant with one cylinder or retort and accessories.

different to the attacks of oxidation or putrefaction under the conditions to which its product is normally exposed. Naphthalin ($C_{10}H_8$), which is a hydrocarbon occurring in large quantities in the heavy coal oil (naphthalin compounds amount to from 30 to 60 per cent by weight), is in its pure state a white substance, taking the form of closely adhering rhomboidal crystals fusing at 79 deg. Cent. (174.2 deg. Fahr.), vaporizing at 212 deg. to 220 deg. Cent. (413.6 deg. to 428 deg. Fahr), and having a specific gravity of 0.9778 at its boiling-point; insoluble in cold water, slightly soluble in hot water, and slightly volatile at normal temperatures.

The heavy or dead oil of tar used for creosoting, according to Mr. Rowe, should not contain more than 1½ per cent of water, 5 per cent of tar, and 5 per cent of phenol or carbolic acid. It must not flash below 85 deg. Cent. (185 deg. Fahr.), nor burn below 93.3 deg. Cent. (200 deg. Fahr.), and must be fluid at 48 deg. Cent. (118 deg. Fahr.). It should begin to distil at 160 deg. Cent. (320 deg. Fahr.), and should yield between that temperature and 210 deg. Cent. (410 deg. Fahr.) of all substances less than 20 per cent by volume. Between 210 deg. Cent. (410 deg. Fahr.) and 243.3 deg. Cent. (470 deg. Fahr.) the yield of naphthalin must not be less than 40 per cent, nor more than 60 per cent by volume. At 2 degrees above its liquefying point it should have a maximum specific gravity of 1.05, and a minimum specific gravity of 1.015.

The "creosoting" process undoubtedly gives excellent results, and is extensively used in this country and in America. Although the first commercially practical plant appears to be due to Bethel, an authentic record of the use of creosote oil, for impregnating timber, as far back as 1756 is said to exist. Bethel's experiments showed that by impregnating the wood with a minimum of 7 pounds of creosote per cubic foot, satisfactory results were obtained in the case of railway sleepers; for marine work he considered that not less than 10 pounds per cubic foot was required. Other experimenters have employed from 10 pounds to 20 pounds per cubic foot. This question will, however, be gone into later.

A standard method of carrying out the creosoting process is as follows: The wood for treatment, having been carefully dried, is steamed and subjected in a retort to the action of a heated vacuum of from 22 to 24 inches, so that the thorough and uniform penetration of the preserving liquid or agent, essential to the highest efficiency, may be insured.

The creosote oil or dead oil of tar is then admitted to the chamber, which latter is still maintained connected with the vacuum pump, at a temperature slightly above that of the boiling point of the sap at the pressure in the retort at the time. During the time that the hot oil is surrounding the wood, and penetrating into the interfibrous spaces, any aqueous vapor that still remains in the wood rises to the top of the chamber, owing to its lesser specific gravity, and is drawn off by the pump, and when the chamber is completely filled with oil all the remaining moisture has passed off.

The exhaust pump is then cut off, and, to facilitate and expedite the impregnation of the wood, a force-pump is started by means of which creosote oil is forced into the chamber or retort until the desired pressure, generally about 150 pounds per square inch, is attained. This presure is held until the wood has received the required amount of the antiseptic agent. The oil remaining is then withdrawn from the retort and dumped into an underground tank, from where it is pumped back into the measuring tank, the difference in the reading of the tank gage before the oil is put into the retort, and after it is pumped back into the tank, giving approximately the amount of creosote oil injected into the wood.

The impregnation being complete the retort is opened, the treated wood removed, and another charge can be inserted. The above practice, it will be seen, consists of two distinct operations, the preparation of the wood and the impregnation of the prepared wood with the preservative agent.

The preparation of the wood consists essentially in the extraction of the liquids, and semi-liquids, which constitute the immature portion of the wood, and are contained in the interstices between the fibers, without softening the cement binding of fibrillæ or bundles of cellulose tissue which form the solid or fully matured portions of the wood. The above operation removes all those portions of the tissue which are liable to fermentative action, and the value of artificially preserved wood depends entirely upon its successful accomplishment.

The amount of pressure to which the wood is subjected in the retort during impregnation is a matter of considerable importance. A high pressure tends to expedite the operation, but it must not be overlooked that too high a pressure is liable to cause injury to the fiber of the wood, by forcing in more of the agent than the natural voids can hold.

The general opinion among experts seems to be that pressures of from 100 pounds to 180 pounds per square inch are the most advantageous, the higher pressures being required for creosote oil and the lower for other agents. Besides injury to the wood, over-pressure also causes a considerable waste of the agent, as when an amount of the latter in excess of the absorptive power of the wood has been injected, the surplus will waste out after the wood has left the retort and be lost. A considerable pressure in the retort, even as high as 300 pounds per square inch, may not at first affect the strength of the fibers of the wood to any appreciable extent, but it may be the cause of serious consequences in after years.

Should the treatment be carried out at too low a temperature, or for too short a period, only the sap or liquid part nearest the surface will be removed, and the space receiving the preservative agent will not be sufficient. Conducting the operation at too high a temperature, or for too long a period, on the other hand, will result in the resinous portion of the bundles of fibrillæ becoming softened and the elasticity of the wood being reduced in a proportion corresponding to the decrease in the coherence of the fibrillæ. According to the practice of the Norfolk Creosoting Company, U. S. A., the temperature should never be less than 100 deg. Cent. (212 deg. Fahr.), or exceed 130 deg. Cent. (266 deg. Fahr.).

Of the two possible methods for the removal of the undesirable portions of the timber, exposure to currents of dry air, and steaming under pressure, with an after-drying in a vacuum, the latter is recommended as the best practice. Although the first method would seem to be the least likely to modify injuriously the physical structure of the wood; in actual working this is found not to be the case. With proper manipulation, a more thorough desiccation, without harmful change of the

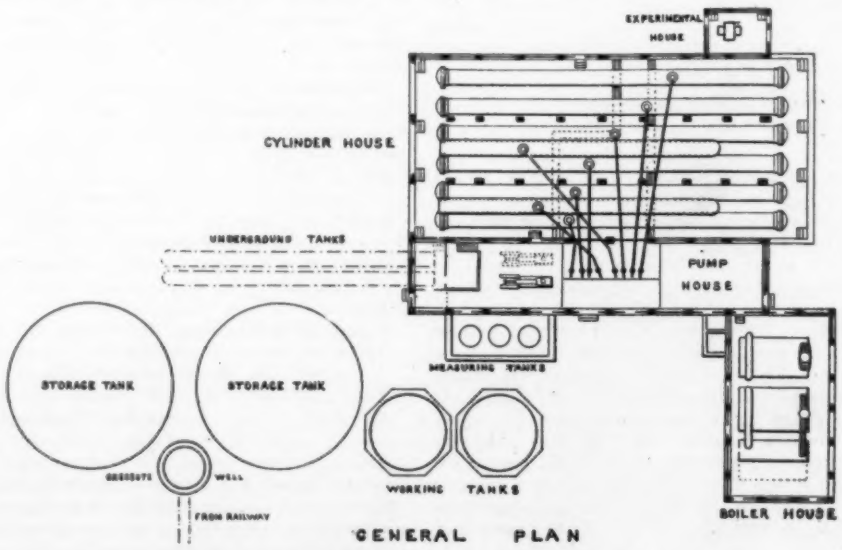


Fig. 9.—Pressure creosoting plant with multiplicity of cylinders or retorts.

*Paper read before the Royal Society of Arts, and published in its *Journal*.

organic structure, can be accomplished in twelve hours less by the latter process than is ever possible with air drying, which, under the most favorable circumstances, is a long-drawn-out operation, and, in any case, cannot do more than extract the water from that portion of the sap which has not yet reached the semi-solid stage; thus leaving in the tissues of the wood a very considerable amount of resinous matter, which occupies space that should be ready to receive the preservative agent. The consequence of this is a failure of the oil to reach many of the interfibrous passages, which are either left empty, or are filled with the gelatinous part of the half-matured growth cells in which are to be found the conditions that make putrefaction possible. In order to remove the sap from wood, it is first necessary to vaporize it and then to bring about such external circumstances as to allow of the outflow of all gaseous matter from the interior of the wood. To vaporize the sap it is necessary to break down the walls of the cells containing the liquid and the semi-liquid substances. This can be readily accomplished through the agency of heat applied through the medium of a moist steam bath at such a pressure as to keep the temperature of the wood, and its surrounding atmosphere, somewhat above the boiling-point of the sap. The maintenance of this condition for a few hours is said to be found to be quite sufficient to break down the sap-cell tissue, and to vaporize all those constituents that it is desirable to withdraw. This point having been reached the steam bath is discontinued, and the temperature being maintained at, or slightly above, the vaporizing point of the sap, the pressure of the atmosphere surrounding the wood within the retort is reduced below that of the interior of the wood. The result of this condition would be an overflow of vapor and air, continuing until equilibrium was restored. This equilibrium is prevented by the use of an exhaust pump until the absence of aqueous vapor in the discharge from the pump indicates the completion of the operation. At this stage the tissue is in a state very like that of a sponge cleared of hot water, every pore is gaping open and ready to receive the agent.

To insure success requires most careful attention and skillful management, and, of course, the provision of adequate and suitable appliances. The attainment of a more or less perfect product demands the consideration of the following points: the wide divergence in the characteristics of timber; the varying amounts of sap due to the lapse of time since, and the season in which the tree was felled; its possible subsequent immersion in water for a longer or shorter time; the character of the soil and the conditions under which the tree grew, whether in a dense forest or a comparatively open country; whether it is of a rapid even growth, or of a slow, intermittent one. To an experienced operator these conditions indicate in each case the proper course to be pursued, and failure to observe and to take them into consideration is to invite indifferent, uncertain, and, in the end, unsatisfactory results.

Of almost equal importance is a proper understanding of the circumstances under which the finished product is to be used. Timber of piers, wharves, and other structures in tropical waters, demands processes and degrees of thoroughness of treatment that are unnecessary in the harbors of more temperate climates, which latter are in turn more exacting than land and fresh water constructions.

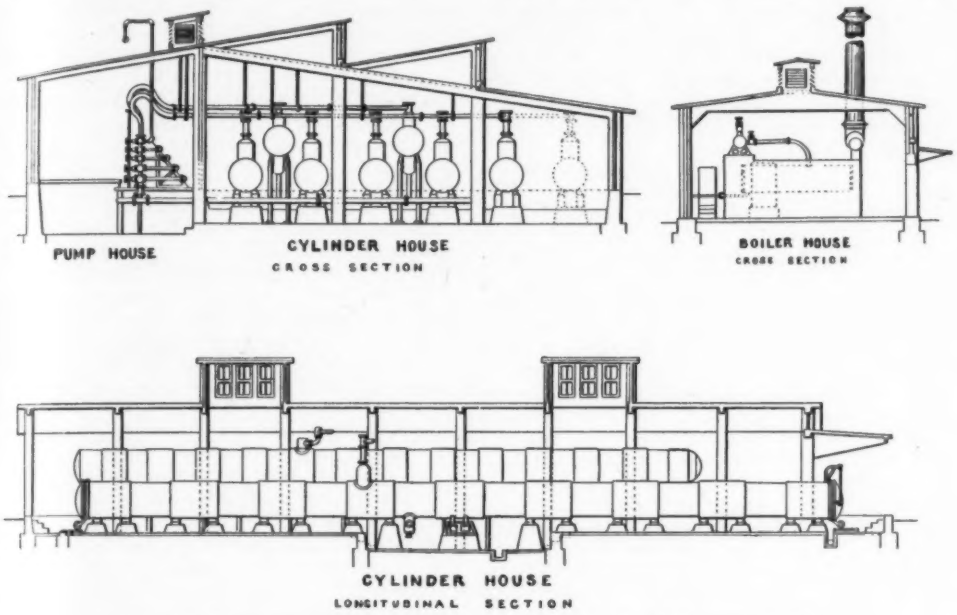


Fig. 10.—Pressure creosoting plant with multiplicity of cylinders or retorts.

The time required to treat any particular wood depends upon the structure, size of wood, shape, and the method of treatment of the wood. For operating the full creosote process with 10-pound treatment, the cycle is as follows: Steaming to 20 pounds pressure, 30 minutes; steaming to 20 pounds to 35 pounds pressure, 3 hours 30 minutes; blowing off, 15 minutes; vacuum, 45 minutes; creosote oil to a pressure of 100 pounds per square inch, 1 hour 30 minutes; forcing back solution, 15 minutes; vacuum, 15 minutes; total, 7 hours.

A simple installation, with one creosoting cylinder or retort and necessary accessories, constructed by the Power and Mining Machinery Company of Cudahy, Wis., is shown in plan, and in longitudinal and transverse sections in Fig. 8. This plant comprises one steel creosoting cylinder or retort; a steel charging tank placed at a level above the retort, and also storage measuring and underground tanks, not shown in the drawing; tie block and bolster cars for handling the timber in and out of the retort; vacuum pumps and condensers for withdrawing the moisture, sap, and surplus preservative; general service or tank pumps for transferring the preservative fluid from the tanks to the retort; pressure pump for injecting the preservative into the wood cells; centrifugal pumps for transferring the preservative, and for agitating the hot creosote oil; air compressor for blowing back the oil from the retort to the tanks, and for agitating and impregnating purposes; pumps for fire protection; feed pumps for boilers; feed-water heaters, open and closed patterns, for preheating boiler-feed work. Also necessary boilers, buildings, hoisting engines, locomotives, generators, motors, requisite piping, valves, special fittings, thermometers, direct and recording pressure and vacuum gages, multiplying float indicators, etc.

Obviously, by multiplying the number of impregnating cylinders or retorts and accessories, the plant may be increased to any desired capacity.

Fig. 9 is a general plan, and Fig. 10 shows longitudinal and cross sections of a plant having a multiplicity of impregnating cylinders or retorts constructed and erected by the Allis-Chalmers Company at Somerville, Texas.

The commercial sizes of the retorts made by the above company are as follows: 72 inches diameter, and 74 inches diameter by 42 feet, 52 feet, 108 feet, and 132 feet in length; 84 inches diameter by 108 feet, and 132 feet in length; and 108 inches diameter, by 132 feet, and 150 feet in length. The shells of the retorts are made of the very best open hearth flange steel of thicknesses ranging from ⅝ inch to 1 inch, depending upon the diameter, working pressure, and preservative agent used, some of the latter causing rapid deterioration of the plates, while others have no injurious effect. The retorts are fitted with the usual rails and steam-heating coils for creosote.

The door of the retort is a most important detail. For low pressures the patterns recommended are, either a plain bolted one with slotted holes and ordinary tee-head bolts; or what is known as a "spider" door with center screw and lever nut arranged so that each lever has independent connection with the frame, such as that shown in front and side elevation in Fig. 11. For high pressures an improved "spider" door, with center screw and lever nut, arranged so that the levers are connected to the frame by a continuous flange ring, would be found suitable; or a solid cast steel bolted door with tee-head swing bolts, such as that shown in front and side elevation in Fig. 12, can be used. All the patterns of doors should have a projecting circular spigot on the door which corresponds with a circular groove in the frame, so that a sound joint can be formed by the insertion of a gasket in the groove. This gasket is usually made of asbestos rope thoroughly dipped and painted with a mixture of graphite and oil. The retort is sometimes fitted with a door at each end.

The opinion of operators as to the best type of door varies, but it may be said that, in cases where time is an important factor, the "spider" door is probably the best, as it can be opened and closed in about 2½ minutes, whereas the bolted doors occupy at least double that time. The bolted doors, however, have less parts, therefore they require less maintenance than the "spider" doors.

The practice in the United States, in the case of what is usually termed the "full-cell creosote process," is to employ a pressure of from 100 pounds to 125 pounds per square inch, the wood fibers and cells of ties or sleepers being impregnated with from 6 pounds to 12 pounds of creosote oil per cubic foot, and piling with from 10 pounds to 20 pounds per cubic foot. Sometimes the wood is subjected to a vacuum at the finish to drain the surplus oil from the exterior of the wood, and thus to prevent loss by drippage after the wood has been removed from the retort. The time occupied in this treatment, omitting steaming, is 3 hours, including steaming; 5 to 7 hours, for sleepers; for timber, including steaming, the time occupied by the treatment is 7 to 11 hours; and for piling, 12 to 24 hours.

The open-tank hot or boiling creosoting process allows of two steeps a week being made. The creosote oil should be heated up to 93 deg. Cent. (199.4 deg. Fahr.) for 8 to 10 hours, to whole of the working day, and allowed to cool during the night. This operation is repeated next day, and when the creosote oil is quite cool the timber can be extracted.

The open-tank cold process occupies from 9 to 18 days, the time taken in absorbing the agent depending greatly upon the species of timber being treated. In both of the above processes especial care is necessary to see that the timber is thoroughly dry before treatment.

Regarding the efficiency of the open-tank method of preserving wood, Mr. Rowe observes that sleepers, and any wood that will make a good paving-block, must be well dried before it can be properly impregnated by this method, and this seems to be the secret of success. Mr. Card, manager of the Chicago Tie and Timber Preserving Company, states that the open-tank method of creosoting will undoubtedly produce good results if it is confined to the treatment of blocks, shingles, posts, etc., or, in other words, small dimension lumber, and it will not be successful in this case unless the utmost care is taken in the seasoning of the lumber before treatment. As regards the treatment of sleepers by this method, he says that a loblolly pine sleeper, provided it is thoroughly seasoned, would probably absorb the greatest amount of solution in the least time, but any other class of sleeper treated on the open-tank method

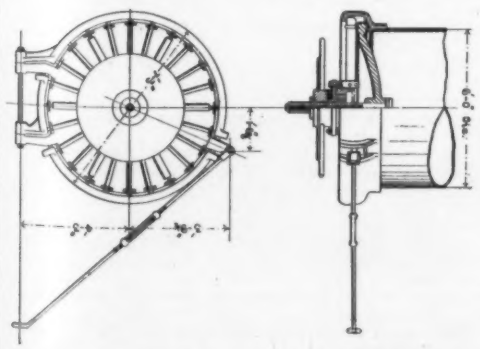


Fig. 11.—Spider pattern retort door. Front and side elevations.

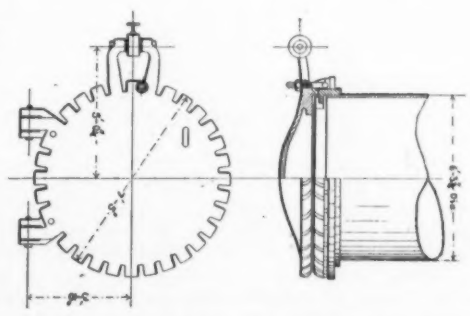


Fig. 12.—Solid cast steel bolted retort door. Front and side elevations.

would take from two to three weeks to absorb the same amount of solution that could be injected under 100 pounds pressure per square inch in 4 hours' time.

The Curtis-Isaacs Creosoting Process.—A process for creosoting, patented some years ago in the United States by W. G. Curtis and J. Isaacs, of San Francisco, consists in placing the charge of timber to be treated in a retort having open vents or ports to the atmosphere, introducing sufficient oil of creosote to submerge the charge, and then heating the oil and timber to a temperature above the boiling-point of the sap at ordinary atmospheric pressure, by which it is claimed that the sap is expelled from the wood. The ports or vents are then closed, and the oil is forced under pressure into the pores of the wood to take the place of the evaporated sap.

The Rueping Process.—Briefly, this process, which is chiefly used with oil of creosote as an agent, consists in forcing compressed air at a pressure of from 80 pounds to 100 pounds per square inch into the pores or cells of the wood (previously either air-seasoned or steamed in a retort), and, at a higher pressure, creosote oil, without relieving the air pressure.

The retort is filled with oil by means of an equalizing reservoir or pump, so as to avoid releasing the air pressure. The oil pressure thus started at from 80 pounds to 100 pounds per square inch is then gradually increased to about 150 pounds per square inch, compressing the air that has been forced into the cells or pores of the wood into a smaller volume, and allowing from about 10 pounds to 12 pounds of creosote oil per cubic foot to enter the wood.

Upon relieving the combined air and oil pressure, and draining the oil from the retort, a vacuum, or rather a partical vacuum, is produced therein, which permits the air inclosed in the cells or pores of the wood to expand and force out the surplus oil from the wood fibers, leaving the latter impregnated, according to some authorities, with from 4 pounds to 6 pounds of creosote per cubic foot, and, according to others, with as little as 2.2 pounds per cubic foot.

This process is claimed to be especially adapted for the treatment of ties or sleepers. The time occupied in treating sleepers, omitting steaming, is about 4½ hours, or, including steaming, 6½ to 8½ hours. The time occupied in carrying out the different stages of the process, using equalizing cylinders, is as follows: Air to 80 pounds pressure per square inch, 30 minutes; transferring creosote oil, 20 minutes; creosote oil to 150 pounds pressure per square inch, 1 hour 30 minutes; maintaining 150 pounds pressure per square inch, 15 minutes; forcing back creosote oil, 20 minutes; vacuum, 1 hour; maintaining vacuum, 15 minutes; draining, 10 minutes; total time occupied, 4 hours 20 minutes.

The Rueping process has been patented in Great Britain, Germany, and the United States. It was primarily devised with the object of reducing the cost of creosoting by preventing the heavy loss occasioned by dripping in the wood treated by the ordinary process.

Messrs. Richard Wade, Sons & Co., of Hull, are concessioners for the Rueping process in the United Kingdom, and several large firms have taken up licenses for the working of the plant. In this country, the writer understands, the usual practice is to force the compressed air into the wood at a pressure of about 50 pounds per square inch.

The Lowry Process.—In the Lowry process the seasoned wood is placed in the retort and submerged in creosote oil, from 10 pounds to 12 pounds of which, per cubic foot of wood, is forced in at a pressure of about 180 pounds per square inch, so as to saturate the pores and cells. The retort is then drained, and a quick vacuum produced and maintained from 1 to 2 hours, leaving the wood fibers finally impregnated with from 4 pounds to 6 pounds of oil per cubic foot.

This process is chiefly intended for the treatment of sleepers, and the time occupied in the impregnation of thoroughly air-seasoned wood is from 4 to 6 hours. The details of the process are: Creosote oil, 2 hours; draining creosote oil from retort, 10 minutes; vacuum, 2 hours; draining, 10 minutes; total, 4 hours 20 minutes. The average temperature of light creosote oil during the treatment is 77 deg. Cent. (170 deg. Fahr.), and of heavy creosote oil 82 deg. Cent. (180 deg. Fahr.).

The Zinc-creosote or Rutger Process.—According to this process, which appears to have been first introduced in Germany by Julius Rutger in the year 1874, the wood, first air-seasoned, or steamed in a retort—preferably both—to reduce moisture and expel the sap, is subjected to a vacuum for 1 hour. The retort is then filled with a hot emulsion formed of ½ pound of dry zinc, from 1.5 to 4 pounds of oil of creosote per cubic foot of timber being treated. Pressure is next applied by forcing in additional emulsion at a pressure of between 100 pounds and 150 pounds per square inch, after which the retort is drained and a vacuum produced and maintained for about ½ hour, to draw out the surplus emulsion from the exterior of the wood, and so prevent loss—as in the process previously described—by dripping after the wood is removed from the retort.

It should be noted that it is necessary either to employ a special oil, or to keep the emulsion in a constant state of agitation during the operation, in order to prevent a separation of the zinc and the creosote oil. The requisite agitation is usually effected by a centrifugal pump, which draws the emulsion from the top of the retort, and discharges it into the bottom through a perforated pipe.

This process, which is likewise intended principally for the treatment of sleepers, requires for the latter, including steaming, from 6 to 9 hours. The full details of the treatment are: Steaming to 20 pounds pressure per square inch, 30 minutes; steaming to 20 pounds to 35 pounds pressure per square inch, 3 hours 30 minutes; blowing off steam, 10 minutes; vacuum, 1 hour; emulsion to 120 pounds pressure per square inch, 1 hour; maintaining 120 pounds pressure per square inch, 1 hour 30 minutes; forcing back oil, 15 minutes; vacuum, 20 minutes; draining, 10 minutes; total, 8 hours 25 minutes. The steaming time is frequently reduced by 2 hours, in which case the time occupied would be 6 hours 25 minutes.

The above process is sometimes, especially in the United States, known as the Card process, from Mr. J. B. Card, who has introduced several improvements in working.

The Hasselmann Process.—The wood, seasoned or steamed or both, is placed in a retort which is then closed, and a vacuum pumped for about 1 hour, the solution being then admitted with the vacuum still on. The solution consists of 1.5 per cent of copper sulphate ($CuSO_4 + 5H_2O$), 0.5 per cent solution of aluminium sulphate (Al_2SO_4), and potassium sulphate (K_2SO_4) in proportion in accordance with the condition of the timber. When the retort is about filled, the main valve is shut and live steam is turned into the solution, through which it is distributed by a perforated pipe, heating the solution to from 118 deg. Cent. to 126.6 deg. Cent. (245 deg. Fahr. to 260 deg. Fahr.), and giving a gage pressure of about 35 pounds per square inch. The wood is kept in this boiling solution for from 2 to 3 hours, when the latter is drained off into a storage tank, or is transferred to another retort.

The main factor in the success of this process is the proper proportioning of the various ingredients in the solution to suit the kind of wood to be treated.

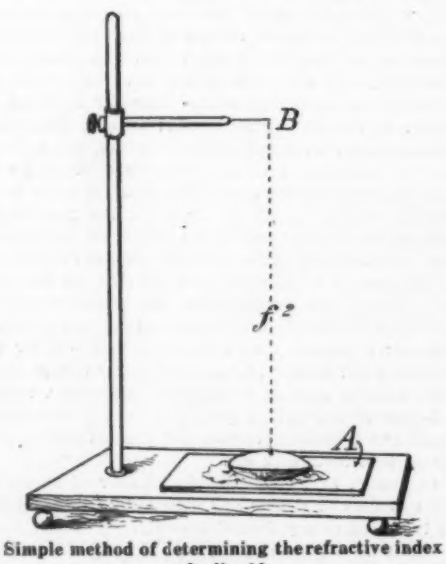
The plant used for the burnettizing process can be used for this process, extra tanks for holding the solution and tanks for mixing the chemicals being, however, required, as well as some slight minor alterations in piping, etc.

(To be continued)

Determination of Refractive Index of a Liquid

THE following simple method of finding the refractive index of a liquid available in small quantities may be of interest. It is given by G. N. Pingriff in *Nature*.

A plane mirror, *A*, is placed on the base of the stand, and on it is put the double convex lens in such a position that its center is beneath the needle-point *B*. With the eye directly above *B*, the observer adjusts the sliding arm until the needle-point and its image just coincide, as found by parallax. The distance from *B* to the center of the lens is then accurately found—let it be f_1. The experiment is then repeated, after first placing a drop of the liquid upon the mirror, when it will be spread out to a plano-convex lens between the glass lens and the mirror—let the new focal distance be f_2; then evidently the focal length f of the liquid lens will be given by $1/f = 1/f_2 - 1/f_1$.



Simple method of determining the refractive index of a liquid.

But since the focal length of the liquid lens is also given by the relation $1/f = (\mu - 1)/r$, where r is the radius of curvature of the surface of the glass lens, it is evident that from a knowledge of r the index of refraction of the liquid can be at once found.

If r is not known, it can be found by putting a sheet of paper between the lens and mirror, and again obtaining an image of *B* coincident with itself by reflection in the lower surface of the lens. If this new distance from the lens be called *d*, we have, since refraction is now only at the upper surface of the lens, $\mu/r - 1/d = (\mu - 1)/-r$, or $r = (2\mu - 1)\ d$, where μ now, of course, refers to the glass, and can, if necessary, be calculated.

The apparatus is thus complete in itself, and three readings of the positions of *B* give all the data required.

Redwood Sawdust is being used by vineyardists in California for packing fresh table grapes. It takes the place of the ground cork used for imported Spanish grapes.

There are About Thirty-seven Pines native to the United States, of which twenty-five are Western species and twelve Eastern.

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